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Exploring Electronics And Technology For The Hobbyist And Professional

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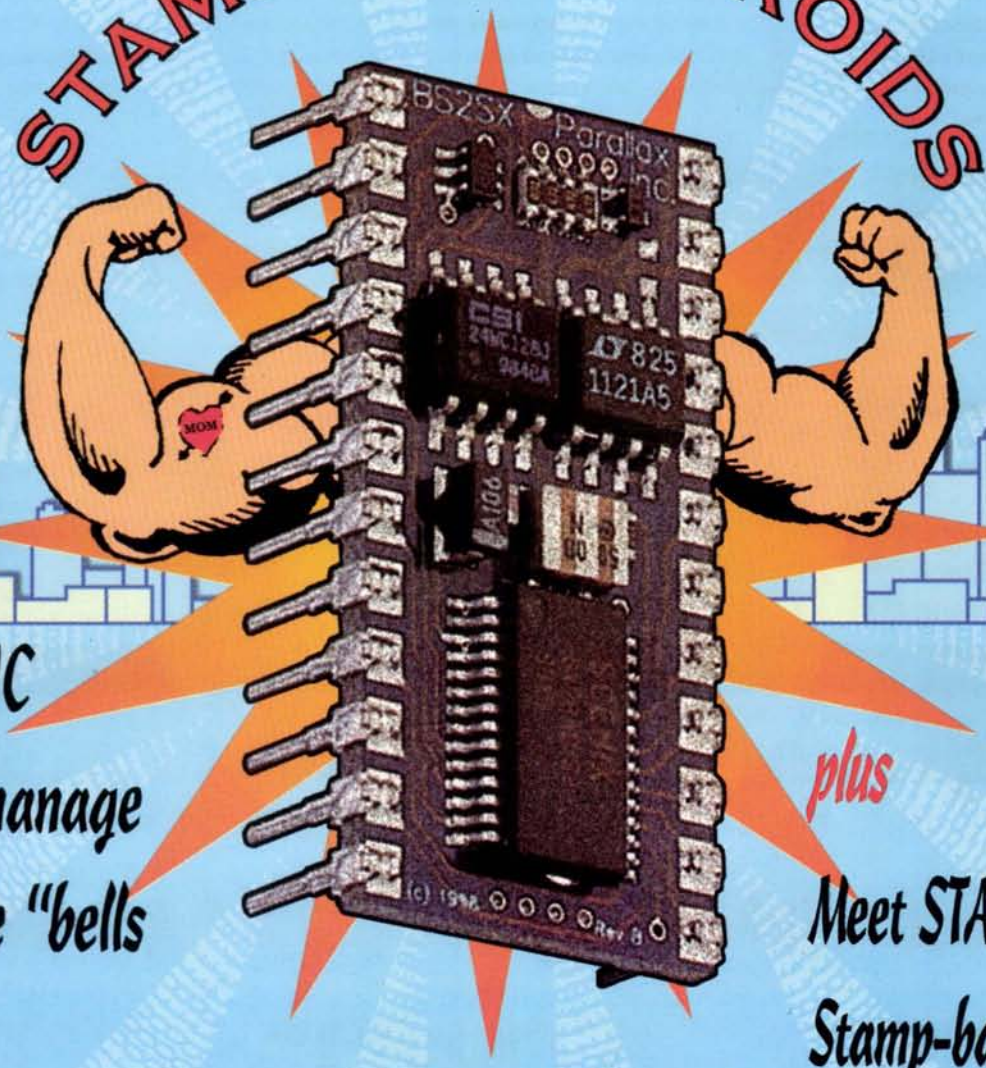
November 1999 Vol. 20 No. 11

STAMP ON STEROIDS



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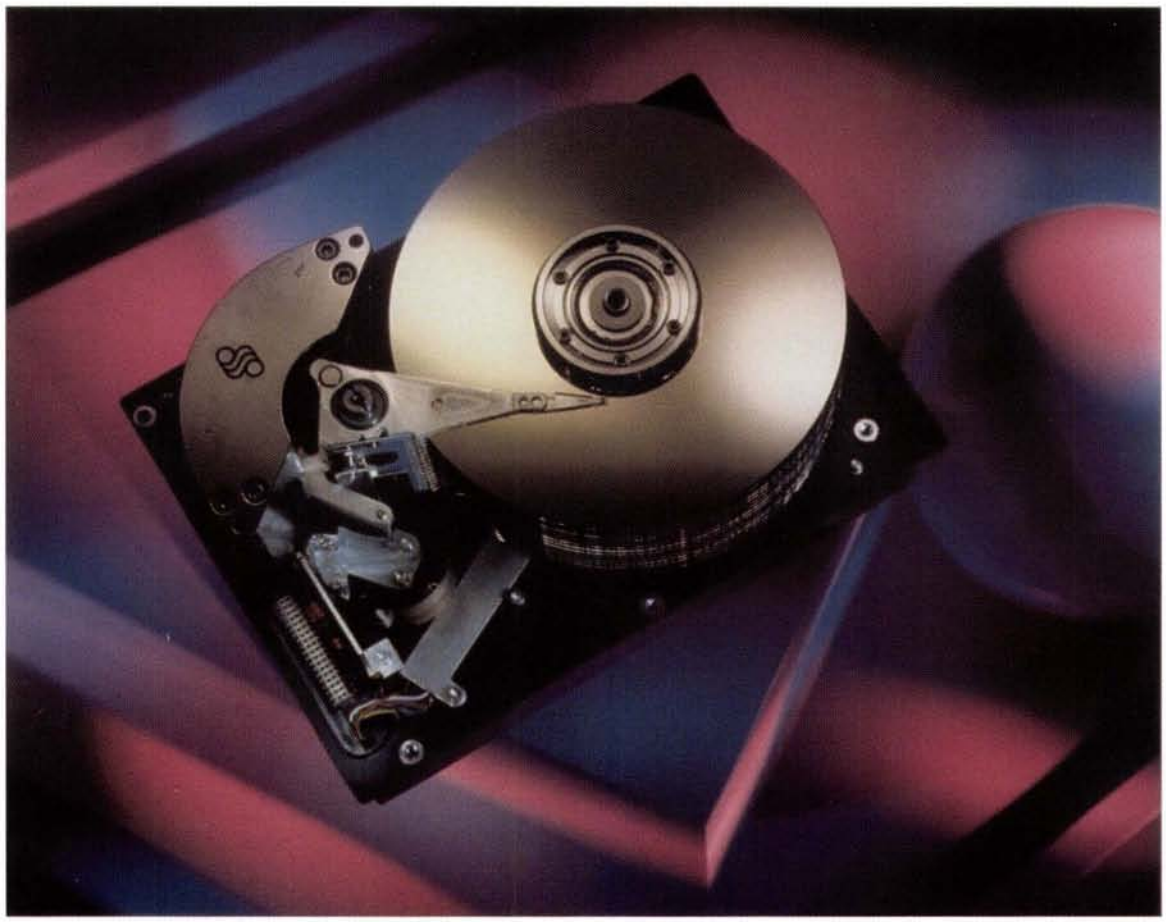

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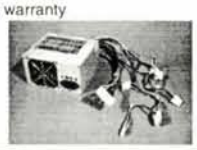

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- These units were sold with Hewlett Packard S-700 workstations for videoconference capability
- We have collected some data, check on our website at http://www.halted.com/online/index.htm
- All we have is cameras with stand, and SCSI-II interface
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- Color camera is digital output, but some delicate SMT surgery will provide NTSC signals (not for amateurs!)
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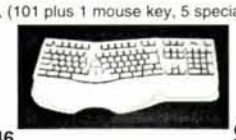

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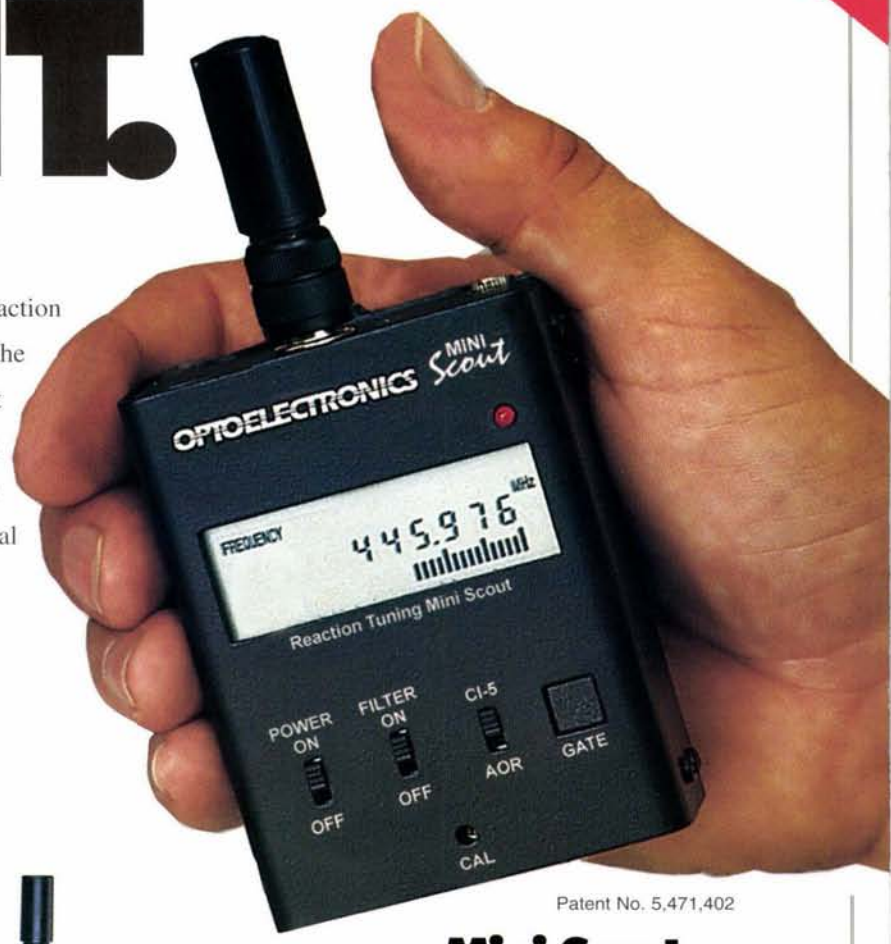

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***Compatible Receivers:**

ICOM
7000, 7100, 8500, 9000, R10
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Radio Shack
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Specifications	Scout	Mini Scout
10MHz - 1.4GHz	•	•
Reaction Tune	•	•
LCD Display	•	•
<3mV Sensitivity	•	•
Signal Strength Bargraph	•	•
Filter Mode	•	•
Capture Mode	•	
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ANY CONTROVERSY ON MASS MERCHANDISING THE HAM RADIO SERVICE?

by Gordon West WB6NOA

About 15 years ago, I received a telephone call from a Mr. Robert Miller, (present) ham call sign K2RM. Miller was doing some fact-finding about various radio services, and the type of equipment that might be appropriate for a first-time buyer. I explained that amateur radio equipment has traditionally been sold by specialized ham radio dealers, and I would anticipate some raised eyebrows by ham operators who might see the equipment selling through non-traditional ham avenues.

"Has the exposure of ham radio in over 7,000 RadioShack stores helped expose ham radio to radio-hobby beginners, including training materials to obtain the amateur radio license?" asked Miller. I about fell off my chair — how many stores are we talking about???

The stores were RadioShack, and Miller wanted to insure a smooth transition into the entry-level ham radio VHF handheld market, along with training books to underscore the federal requirements to pass the amateur radio examination before transmitting over the two-meter airwaves. The books were written from Novice through Extra, Morse Code tapes were produced specifically for learning the code and then increasing code speed to General class 13 wpm, and RadioShack's HTX-202 two-meter handheld came in, manufactured overseas by Maxon only for RadioShack. While the HTX-202 *could* take an old ICOM 2-AT battery pack, the equipment was *not* made by ICOM, nor was there any way to alter it to receive out-of-band signals. But it was quite a handheld, and featured band-pass tuning which made it virtually intermod free.

When the radio and training materials hit town across the country, both ham radio manufacturers and ham radio dealers cried FOUL! These inexpensive ham sets might actually get sold to non-hams! Yet many of these dealers were selling mail order on the word that the buyer had just passed a ham test, or selling into marine fishing markets, or selling to buyers who expressed an interest to begin monitoring the airwaves and promised not to transmit until the license arrived.

The inrush of non-licensed radio operators on the two-meter band, talking illegally over the airwaves, *never occurred*. Thanks go to Miller and his staff for the training of RadioShack sales personnel to fully explain the ham radio license requirements to potential buyers, and steer those buyers to 49 MHz no-license equipment if they had no interest in studying for the test.

And guess what happened — ham dealers across the country began to see the ham radio service *grow* with this increased public exposure of equipment, and the availability of my ham radio books and tapes at their local RadioShack store. The RadioShack exposure of the ham radio service was such a big success that the prestigious American Radio Relay League (ARRL) began selling *their* entry-level book, along with a store database of volunteer examiners, volunteer elmers, and a listing of local amateur radio testing dates. Miller reports that many store managers were actively giving out local ham radio referrals, and local elmers and clubs were quite pleased with this additional exposure.

And the little HTX-202 was a solid performing entry-level handheld, and it was an inexpensive way to get on the air and learn more about the more elaborate beginner equipment available at the local specialty radio store, just down the street or across town. Needless to say, ham specialty dealers began to see that the RadioShack exposure of the ham radio service and beginner ham equipment was actually *good* for their overall walk-in and call-in sales.

Janet Margelli KL7MF, manager of Ham Radio Outlet, Anaheim, CA, talks about the over 150 years of collective employee ham experience at her store.

Justin Buker KD7BOQ operates the Tech America ham station.

In recent informal surveys that have been conducted, about "How did you get into ham radio?", over 40 percent of the respondents indicated they learned about ham radio from RadioShack, or were referred to RadioShack for their ham radio training materials from this author, as well as the training materials from the ARRL. And for learning the code, over 60 percent indicated they started with RadioShack code tapes to begin learning the dits and dahs.

RadioShack has recently expanded their

exposure of ham radio equipment and training materials into their burgeoning chain of technical equipment stores called Tech America.

The popularity of these electronic parts-and-equipment super stores has been so great that they have expanded the chain as "RadioShack.com." If you regularly work in electronics and electronic parts, you will discover these stores, as well as their huge catalog as the ultimate resource for that teeny little coil, that specialized kit, or for high-tech test gear like Fluke.

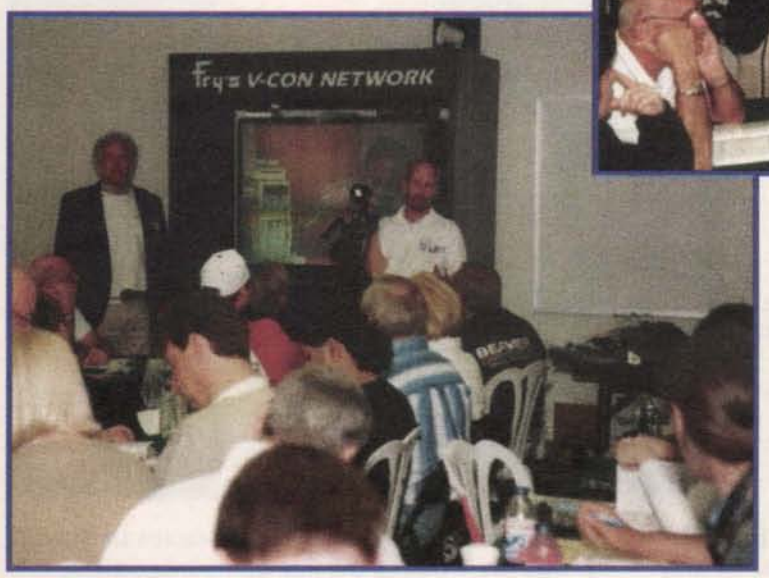
And ham radio! Big names like Alinco, Cushcraft, Alpha Delta, Rohn Towers, Rainbow and Vectronics radio kits, Valor, Standard Radio, and their own line of single-band and dual-band base and mobile antennas.

"We get a lot of technical personnel who will stop in and look over our shoulder as we operate our in-store ham station," comments Justin Buker KD7BOQ. "And this gives us an opportunity to tell our customers about all the local ham radio clubs that can help them break into the ham radio hobby," adds Earl Cantie KD7EMK, of Tech America. Both Justin and Earl are active on the air, operating the stations both at home, mobile, as well as at Tech America in the Mesa, AZ, Tech America store.

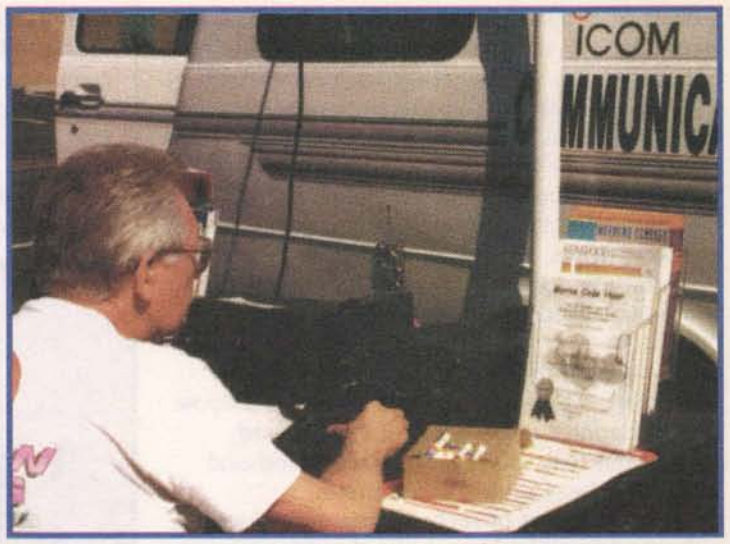
"We find many of our technical customers interested in building ham radio kits, too," adds Jed Peretz, General Manager of the Tech America, Mesa, AZ, store.

Is a non-ham-specialized general electronics superstore a good spot for ham radio recruitment? We say an absolute YES!

Gordon West doing a teleconference ham demo for Fry's Electronics sales personnel and customers.



Ham Day at Tech America Mesa, AZ store.



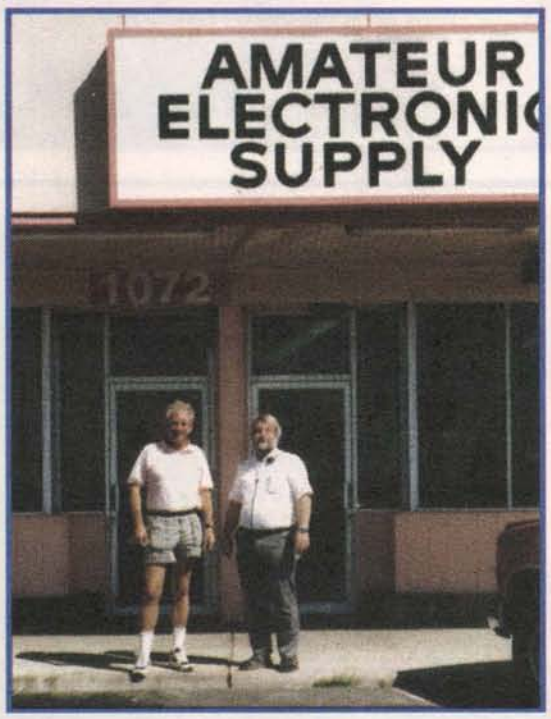
During field day a year ago, we set up our amateur radio recruitment communications van in front of Fry's Electronics corporate headquarter store in San Jose, CA. "The van was mobbed all day, and we saw many of our customers purchasing ham radio training materials to become a licensed operator," comments David Randolph KF6JPE, the merchandising and operations supervisor of Fry's Electronics corporate. "And many of our customers went into local ham radio clubs to obtain training; and when they graduated by passing their ham radio tests, many came to us and some also went over to local ham specialty stores to load up on equipment," adds another Fry's representative.

Fry's personnel also attended some of these licensing classes in order to learn more about ham radio themselves, as well as obtain the amateur radio license as a hobby. Fry's carries a full complement of amateur radio equipment and accessories, and was one of the first to bring on Kenwood and Alinco amateur radio equipment.

And I can tell you first-hand, Kenwood and Alinco product managers took some severe heat from the specialized ham stores because they were one of the first companies, along with West products and ARRL materials, to sell mass merchandisers.

And guess what — after the smoke cleared, most local specialty stores just down the street from Fry's Electronics also enjoyed a pick-up in amateur radio sales from those hams who needed more specialized equipment and technical advice on how to grow further in the amateur radio hobby and public service.

Kenwood went so far as to develop a ham radio primer booklet specifically for the technical and non-technical non-hams to learn more about the ham radio hobby. And this is not just a little three-pager — this is a 24-page, color-cover, illustrated manual that not only "sells" the ham radio service, but also gives out key toll-free telephone numbers about how to learn more about the service, including ARRL, W5YI, AMSAT, and ARES/ RACES contact informa-



Author West (left) and AES Las Vegas store manager Squeak AD7K present a parking lot demo of ham radio at a local APCO convention.

tion. The ARRL also supplies both Fry's, as well as RadioShack and Tech America with promotional free ham radio handouts, too.

And all of these stores are eager for local ham radio clubs to work with the store manager for a spot to put up ham radio club announcements, ham radio exercises, and local ham radio elmer and testing contact phone numbers.

These stores also encourage ham radio demos in connection with their store.

Our most recent Tech America Mesa, AZ, communications van display drew both licensed, as well as soon-to-be-licensed radio operators to the facility and parking lot to see what's new in ham radio equipment, what's happening with the new regulations soon to be announced by the Federal Communications Commission, and a one-on-one discussion with local and visiting radio experts.

And how are the specialized ham radio dealers taking the expansion of equipment into mass merchandisers? At first they were outraged. Some dealers said they would either pull the lines or boycott them. And then when things cooled down, guess what happened ... a steady stream of new candidates coming into the specialized store, seeking more personal attention from long-time ham radio experts on the planning of their future station, and more than likely the ultimate purchasing of that step-up ham equipment from the specialized dealer.

"Having one of these big super stores down the street selling a limited selection of ham equipment may actually do us more good than harm," comments a local Southern California ham radio specialized dealer. "Our store alone has more than 130 collective years of ham radio experience, and this is something that only *we* can offer when the new ham may wish to get real serious about our great hobby," adds the specialized ham store sales person.

It appears the controversy of the big chain stores offering selected pieces of ham radio equipment is no longer a dispute, but rather is turning into an opportunity for further exposure of the ham radio hobby to electronic enthusiasts who may know little about what it takes to get a license and get on the air. And with Tech America offering such a complete line of hard-to-find technical parts and gadgets for the electronic technician, we could very easily see for technical types getting back into a hobby which has recently been going more to family interest, rather than high tech.

But most important to the amateur service is the Tech America, RadioShack, and Fry's willingness to support amateur radio exposure to non-hams through in-store displays, parking lot demos, ham club donations, and an up-to-date computer listing of local test sites, local elmers, and local clubs through the efforts of the ARRL.

And best of all, if the radio hobbyist is not really that interested in working hard for the ham ticket, the RadioShack's, Fry's, and Tech America's have plenty of Family Radio Service, GMRS, and 49/900 MHz no-license equipment to sell the radio hobbyist if they don't think they can make the ham radio grade.

So the times, they are a changin'. The specialized ham radio dealers will *always* be the very best source of the ultimate complete line of makes, models, and varieties of amateur radio and shortwave equipment. But for scanning, CB radio, kits, and parts and projects, and individual coils and caps, the electronic superstores are finding a nice balance with their customers who may have come in for an electronic part, but leave with not only the part, but with an exposure to amateur radio equipment and licensing materials, as well as a computer readout of their local ham radio club.

Who's selling ham radio equipment in *your* area? Spend some time with them and see all that they are doing for the amateur radio service. NV

RADIO CONTROL SERVOS — A PRIMER!

To show the relative size of modern radio control model airplanes, shown is Michele Green (Santa Ana, CA) along with the "Tsunami," an airplane built and flown by Tom Easterday of Brea, CA. It is a giant scale racer, intended for Reno-style racing, and capable of speeds in excess of 200 mph.

The radio control hobby is alive and well — *unbelievably so!*

by Eloy Marez

The technology involved is as advanced as related disciplines allow; to include not only reciprocating but also turbine engines and control systems, using every transmission, control, and display techniques available.

Competition is at Olympic levels, with events in which qualified contestants vie for over $100K in aerobatics, while others race $10K airplanes over a Reno-style course at speeds (actual, not scale!) of over 200 MPH.

The subject of radio control servos is not new here in the pages of *Nuts & Volts*, as they have been found to have many uses in robotics and other electro-mechanical applications.

They are truly amazing little devices, generally well-built both mechanically and electrically, precise in their operations, and inexpensive — at least in some cases — though they can also be somewhat expensive.

Most mentions of R/C servos here in the past have dealt only with the low end of the line, those generally marketed in the radio control (R/C) world as "standard" servos; basic units favored for entry level and sport activity. Such servo — all very similar regardless of the maker — generally develop some 50 ounce/inches of torque at a speed of .20 seconds for 60 degrees of rotation of the output wheel. In size, they measure an average of .75(W)" x 1.6(L)" x 1.4(H)" and weigh around 1.5 ounces.

There are many other types of R/C servos, smaller and larger — much, much larger, which I would like to acquaint you with. But first, a short refresher as to what makes these useful devices tick — pun intended!

Radio control servos are controlled by a Pulse Width Modulation (PWM) signal, the standard being 1.0 to 2.0 milliseconds long, with centering at 1.5 mS. So commanded, most R/C servos travel about 60° stop to stop; that is, ±30° each side of center, though a few will go as much as 90° total.

The radio systems themselves use either Pulse Code Modulation (PCM) or Pulse Width Modulation (PWM) for encoding at the transmitter; the latter being completely erroneously referred to in most R/C material as PPM (Pulse Position Modulation). Regardless, the output of the receiver decoder — both PWM and PPM receivers — is PWM, with the above timing, at an amplitude of at least 3.5 volts.

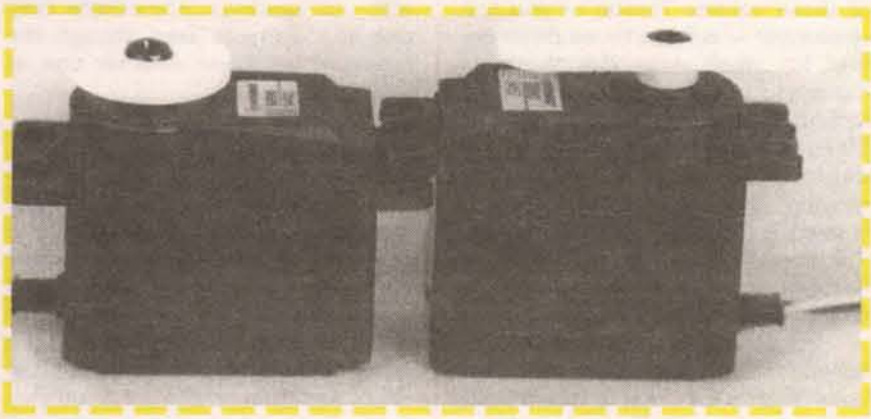
In the R/C system, a multi-channel (read: multi-servo!) system, the encoding starts off with a long sync pulse, followed by a string of 1.0 to 2.0 mS pulses, one for each control channel. The total time of the sync pulse plus all of the control pulses — generally on the order of 20 mS — is referred to as the "frame rate." We can then see that each servo in the string receives a control pulse every 20 mS, or 50 times per second.

At this frame rate, the servo will travel smoothly from one end of its travel to the other. Slowing the rate will cause it to visibly skip from one position to the next as each control pulse is received.

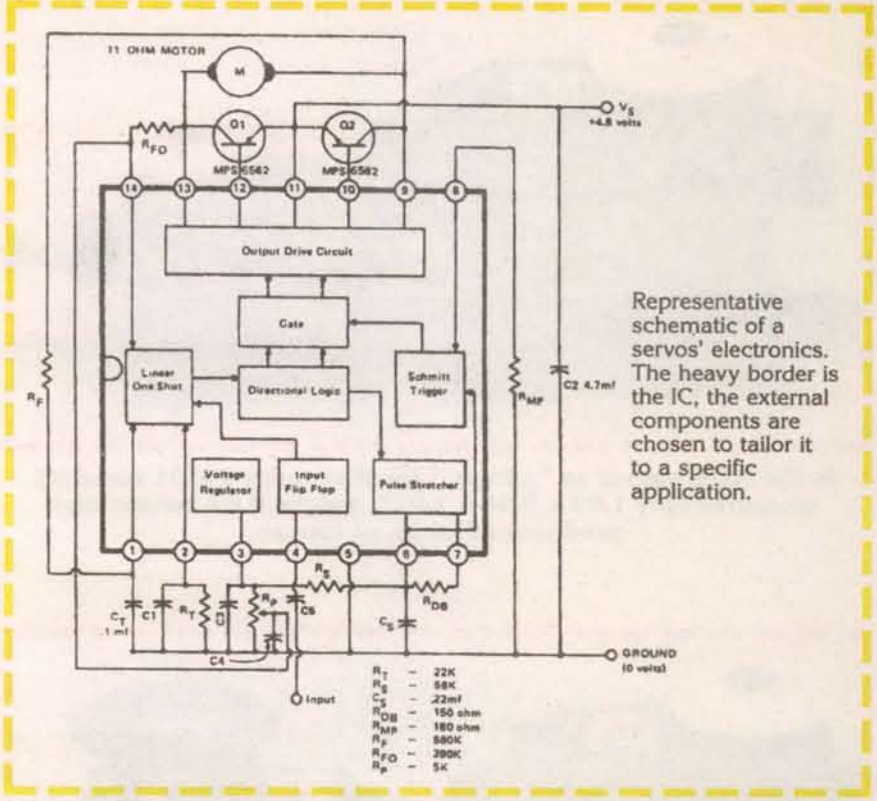
While a faster rate can actually be applied, its benefits are limited by the mechanical design. That is, since the motor has a terminal speed, commanding it to go faster will have no effect.

In a non-R/C, single servo application, the sync pulse is not necessary — the pulse generator needs

The so-called "Standard" servo generally featured in previous *Nuts & Volts* articles, measures approximately 1.5 x .75 x 1.5", weighs about 1.5 -1.6 ounces, and produces about 50 oz.in. of torque.



Only slightly larger than its standard (I) sibling, the Airtronics 94257 and 94258 servos are rated at an unexpected 110 oz.in./.06 sec. and 145 oz.in./.09 sec., respectively.



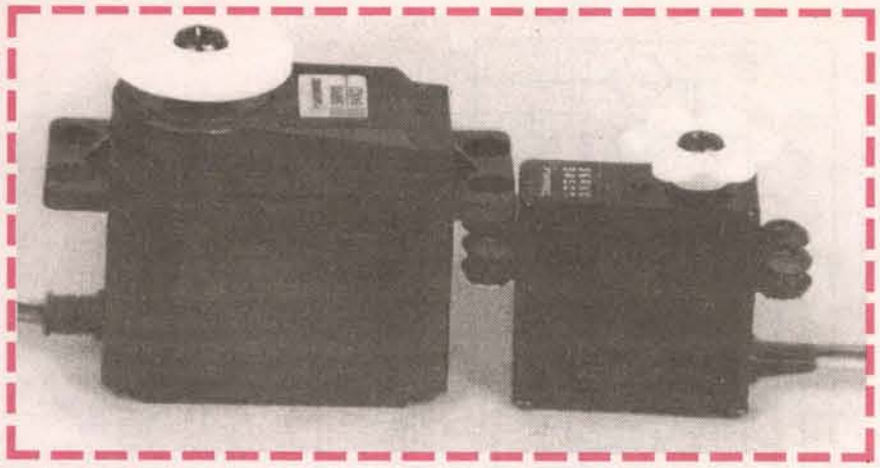
Representative schematic of a servos' electronics. The heavy border is the IC, the external components are chosen to tailor it to a specific application.

only to provide the 1.0 to 2.0 mS pulses at a minimum of 60 Hz rate.

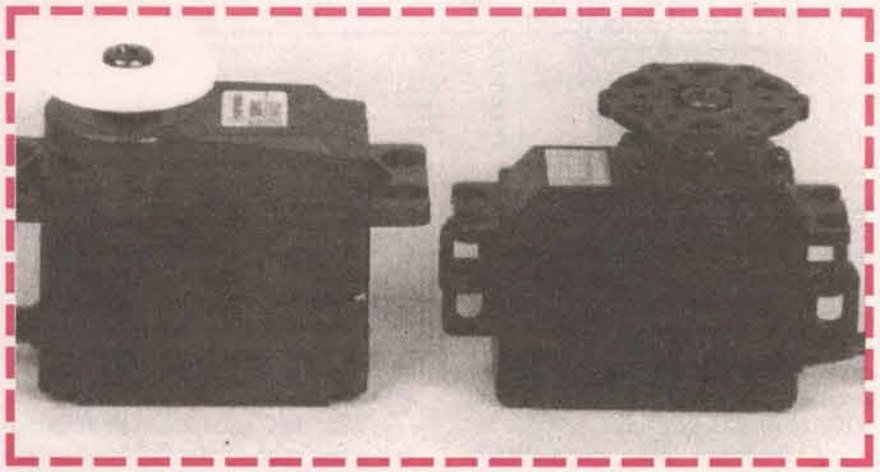
What is happening inside? First, there is a reference pulse generator set at 1.5 mS. Its output, and that of the incoming pulse, are fed to a comparator, where the difference, if any, is detected. This difference ultimately results in a DC voltage being applied to the motor, its polarity determined by whether the difference in the length of the incoming pulse is plus or minus.

A feedback pot, mechanically coupled to the motor via the gear train, then adjusts the output of the reference generator; when it matches the incoming pulse, the difference is canceled, the DC to the motor is removed, and the action stops — until an incoming pulse of a different length is detected. Clever, huh! And all designed and produced primarily for hobby use!

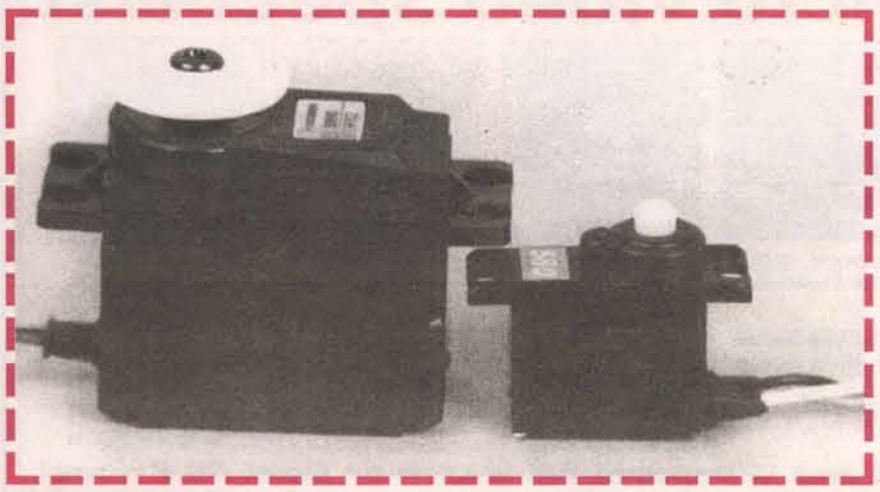
With the exception of filtering and a few components needed to tailor the electronics to a specific use, everything is included in an IC



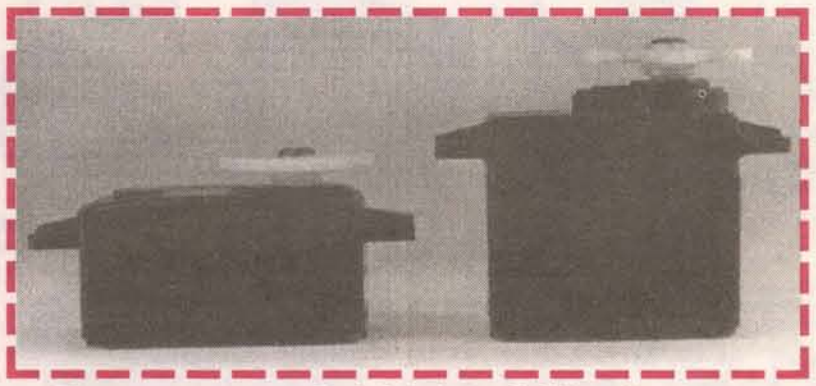
In the class named as "micros," the Airtronics 94501 servo (r) measures only 1.07 x 0.50 x 1.07", weighs 0.57 ounces and produces 29 oz.in. of torque.



Unique for having mounting ears on the case sides, the Airtronics 94141 and 94145 servos measure 1.42 x 0.60 x 1.29", weigh 1.11 ounces, torque being 45 and 33 oz.in., respectively.



Representative of a mini available in a number of different brands, the imported servo shown here (r) is a tiny 0.78 x 0.43 x 0.86", capable of torques from 10 to 20 oz.in.



The squat servo on the left is intended for retract gear operation, close in size to the standards except for height. It is available as positionable and non-positionable versions.

designed specifically for servos. However, the more sophisticated ones to be described — capable of developing much higher power than the "standard" servo — require the addition of external (to the chip) drive transistors capable of carrying the higher current used by the motor. These range from common TO92, to SMD MOSFETS, and in the *really* large servos pictured, TO220 transistors are used. Let us discuss some of the terminology you will run into when you get away from the standard type of servos.

TORQUE AND SPEED

All R/C servos are rated for both of these values. Torque — you will remember — is force times distance, and for small units like these, is expressed in ounce-inches. Standard servos, on the average, are rated at 50 oz.-in., that is, when fitted with a one-inch arm, they are capable of moving 50 ounces. If a two-inch arm is used, it can only move 25 ounces. The speed is given in fractions of a second, and is normally stated for either 60 or 90 degrees.

Traditionally, the torque and speed values were given with 4.8 volts (four Ni-Cd cells) for power but, in recent years, because of an increased interest in larger model aircraft, many users are powering the system with five Ni-Cds, or six volts, and now some of the servo manufacturers are rating their products at both voltages. Most servos will safely stand six volts, and some 20 percent increase in performance can be expected. All torque values stated in the captions are manufacturers ratings at 4.8 volts.

GEARS

Within the standard servo, you will find some precisely molded plastic gears. However, those servos rated for higher output torque generally incorporate metal gears. Such servos are generally a little noisier, and actually wear faster, but they can also withstand much higher reverse loads without gear damage. In their intended hobby use, time has not proven one type to be more durable than the other, and probably as many prefer one as do the other. One of the claimed benefits for plastic gears is that being lighter, they allow the servo to reach full speed faster, and to coast less.

One of the definite advantages of plastic over metal is their replacement cost; $5.00 or less compared to $25.00 or more.

BALL BEARINGS

In a few of the standard servos, the load bearing output gear rotates within an Oilite or brass bushing, but more commonly, they are running in the plastic top case. The better class of servos support the output gear with ball bearings. Sometimes only one at the top is used, though the top-rated units use another one at their base.

INDIRECT DRIVE

Remember that feedback pot mentioned above? Well, in some designs, the output gear is attached directly to the pot shaft and, under loaded conditions, will cause it to move sideways enough to lift the wiper off the pot element, enough to effect some unwanted servo output. An indirect pot servo uses either a different gear to drive the pot, or some sort of a flex coupling to prevent this effect, and is a desirable feature in better servos.

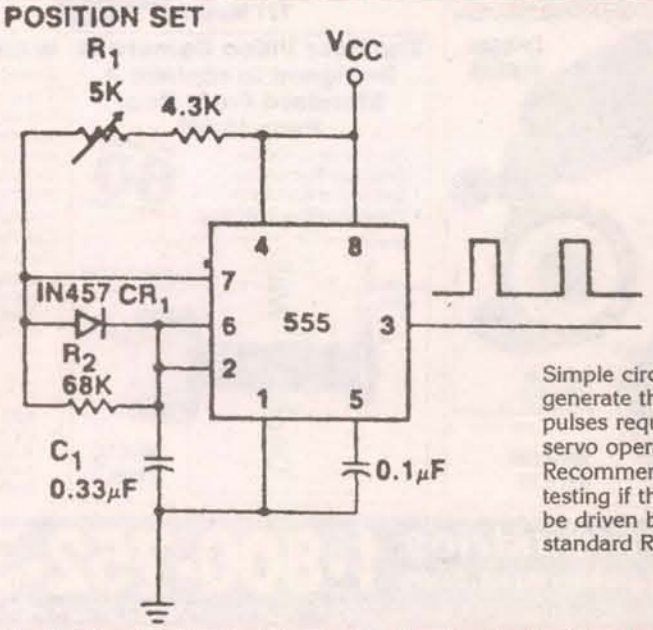
CORELESS MOTORS

Found only in the better, more powerful — read: more expensive! — servos, the coreless motor is one designed without the traditional heavy armature, the winding being potted and self-supporting. The results are less inertia; the motor speeds up and stops faster, increasing the positioning precision of the servo. Coreless motors, being more powerful than their cored brethren, means a higher torque output in the same size servo.

MICRO-PROCESSOR SERVOS

Previously, I mentioned that the

POSITION SET



Simple circuit that will generate the control pulses required for servo operation. Recommended for testing if the servo is to be driven by other than standard R/C systems.

control pulse to the motor is applied at some 50 Hz, a value actually determined by the radio transmitter of the R/C system. The latest servo development incorporates a micro processor within the servo amplifier which converts that relatively low frequency to one much higher, resulting in frame rates (see above) from four to eight times shorter.

The results are a faster acting, more precise servo; one capable of producing more holding power. Their standing current — that is the current while they are at rest or not otherwise loaded — is also higher than the common variety. But then, we all know that electronics teaches us much faster than any other discipline that you never get something for nothing.

There are two such servos currently available: one a German design from a company known as "Multiplex," and available in this country from: Multiplex USA, 5399 Harter Lane, La Canada, CA 91011; (800) 375-1312, FAX (818) 790-1346. The Multiplex servos are unique, in that with the use of an external programmer, their output direction, amount of output rotation, and even the speed can be tailored as required.

The other such servos, actually termed "Super Servos" by their manufacturer, are from a Japanese company known as "JR," probably derived from "Japan Radio Control." The US importer is Horizon Hobby Distributors, 4105 Fieldstone, Champaign, IL 61821; (217)355-9511, FAX (217)355-8734. As far as is known, Horizon's JR equipment is available only from retail sources, and the Super Servos, while having the basic advantages derived from using the micro processor, do not include the programming features. In either case, be prepared for much higher than normal servo prices!

RETRACT SERVOS

Named after their primary function, retract servos are intended to operate the landing gear in the R/C airplane. They are available as normal positionable versions, and those with which, when commanded, rotate only from their extreme CW to CCW positions. When used in a specific application, they offer the advantage of greater torque in a less-tall package.

SAIL WINCH SERVOS

Intended to position the sail in a model sailboat, sail winch servos are much larger than the normal car and/or airplane servos. They are relatively slow, though more powerful, are equipped with a much longer arm, and rotate approximately 180°.

APPLICATION

Like everything else, the proper application and use of a given servo will pay off in reliability and longevity. There are some basic guidelines.

CENTERING

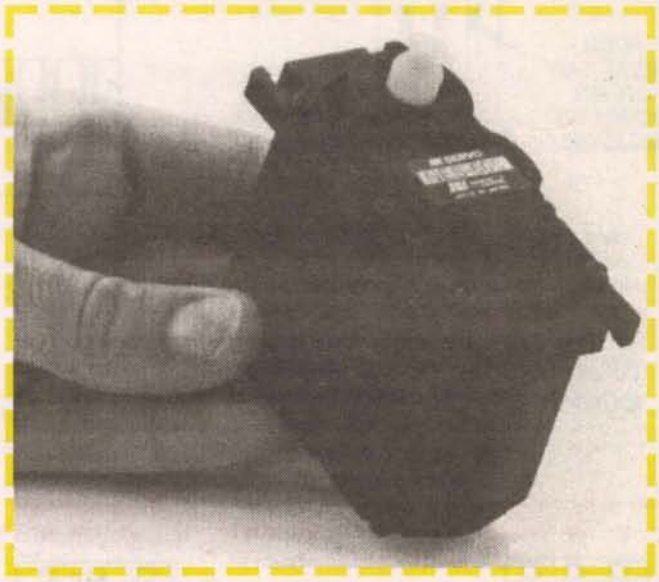
As stated, the servo centers at 1.5 mS. It is important that this value be as accurate as possible, and that the mechanical linkage to whatever the servo is to operate also be adjusted to the center of its travel. There are two reasons for so doing. Most servos include a built-in mechanical stop that limits its total travel to slightly over 200 degrees. More about that later! If the control signal exceeds the indicated values significantly, it can drive the servo to the limits of its mechanical stop and stall. Operating it in that condition will cook something sooner or later.

Similarly, if the external linkage bottoms while the servo still has further movement, the servo will stall and eventually start sending you smoke signals.

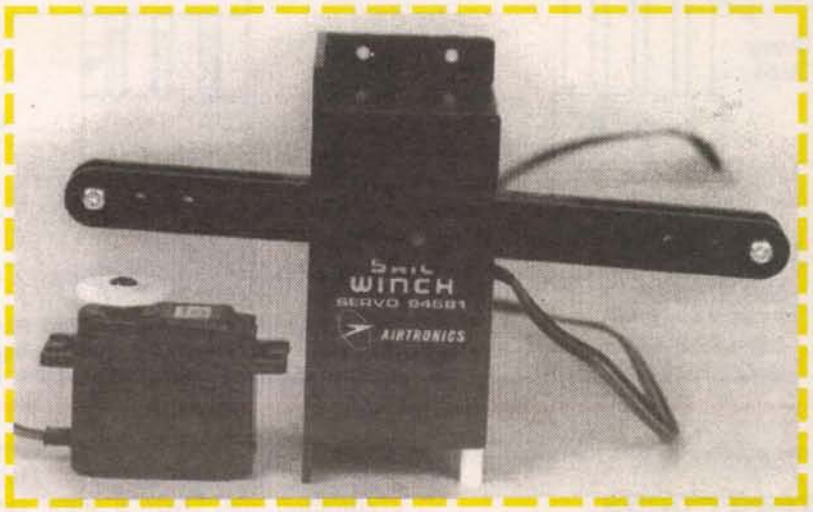
SERVO SAVER

To prevent damage in the manner just described, a special output device, called a "Servo Saver" is made available. It incorporates a strong coil spring that does not inhibit normal servo operation, but if its movement is restricted, the spring takes up enough of the back pressure to prevent any damage to the servo. Servo Savers are available through normal R/C hobby outlets.

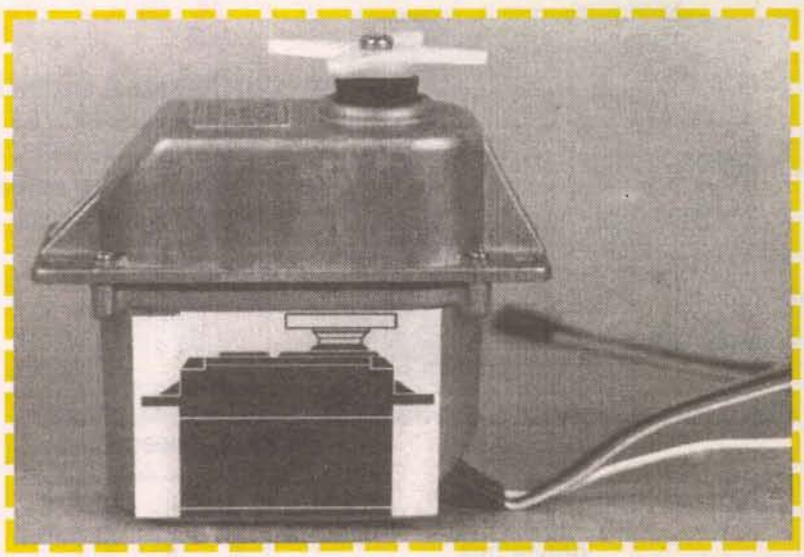
DO NOT TURN THE SERVO OUTPUT! Manually, that is — do not grab the servo wheel or arm and turn it back and forth. The gear ratio is extremely high, over 300 to 1 in some designs. Forcing it to rotate backwards puts tremendous pressure on the motor pinion and succeeding gear, sometimes distorting the teeth. Think about it, there is absolutely no reason to operate or



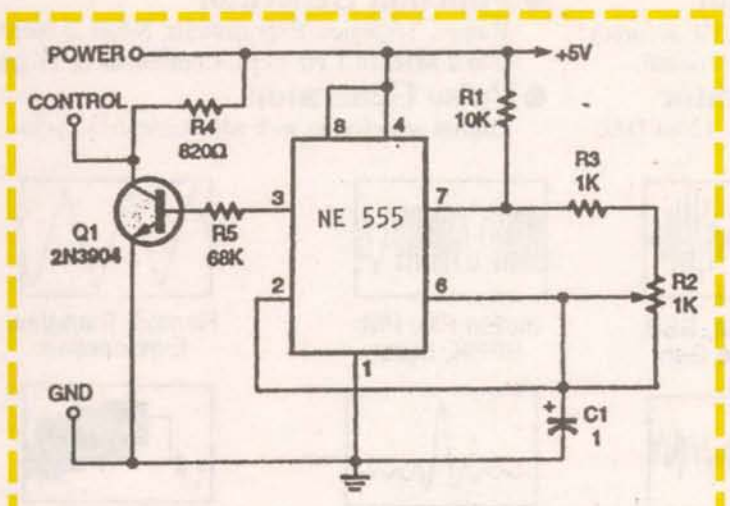
Classified as "Giant or Quarter Scale" servos, the biggie seen here (JR-605) is 2.30 x 1.26 x 2.50" in size, weighs 4.75ounces and produces 139 oz.in. of torque.



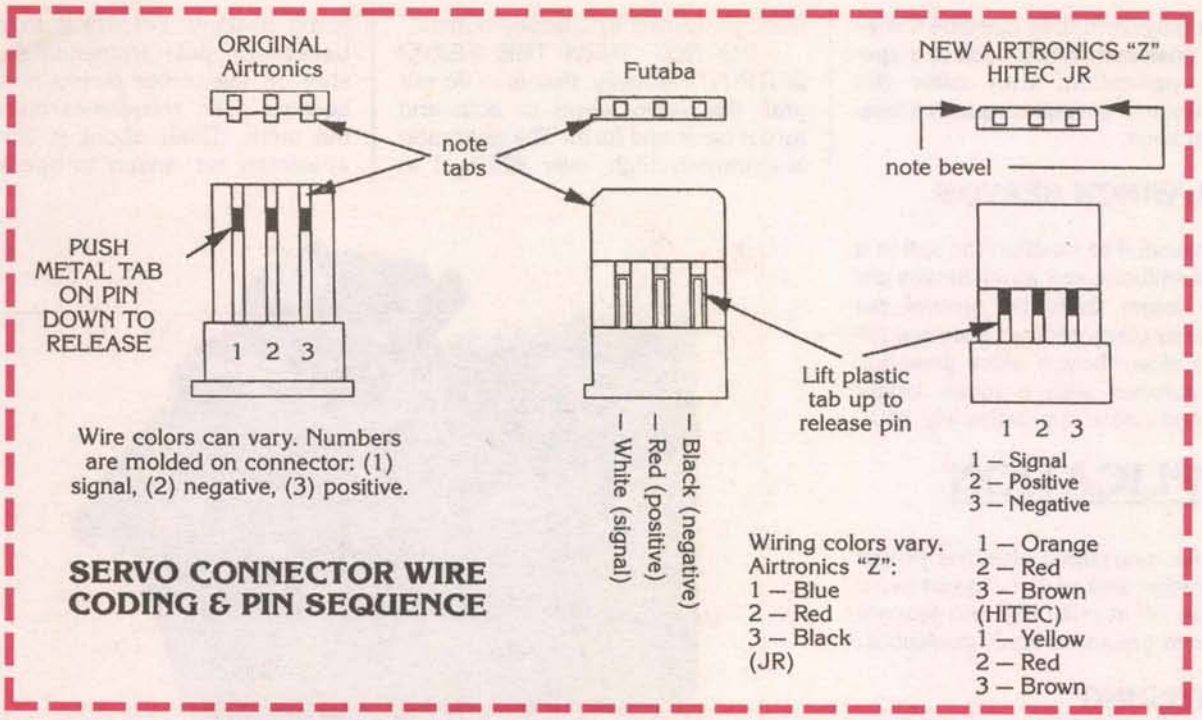
Representative of the Sail Winch servos available, the Airtronics 94581 is 3.65 x 1.58 x 1.78" at 4.94 ounces, produces 10 oz.in. of torque at a speed of 5.0 seconds for 170 degrees.



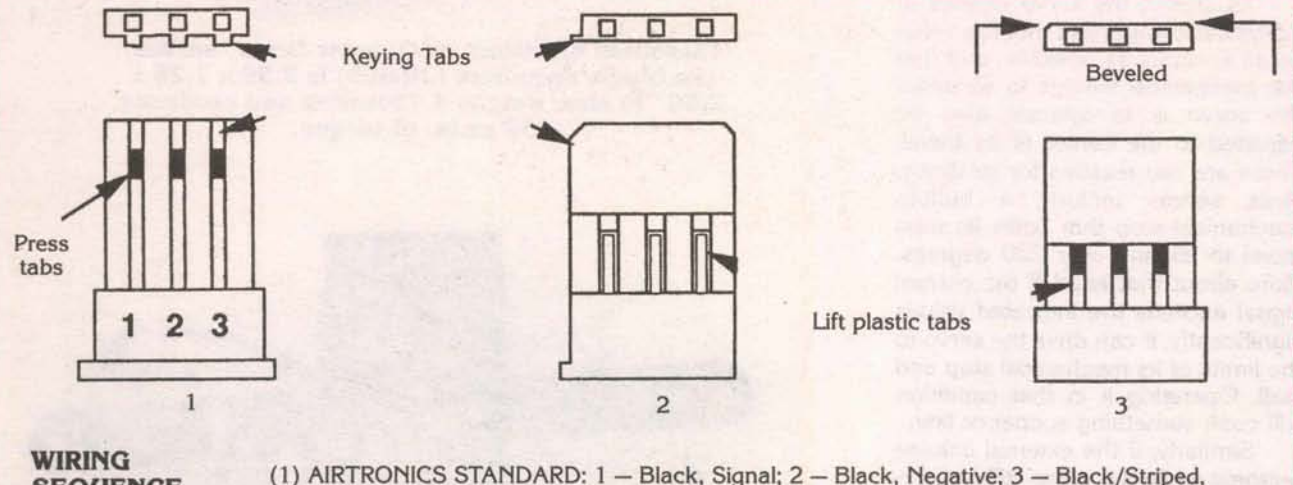
With a sketch of a standard servo attached for size comparison, the PS-050 from Condor R/C (see text), though not a hobby servo, but operated by the same command signals, measures 3.94 x 1.73 x 3.66", including mounting and output arm. It weighs 10 ounces, produces 113 to 159 oz.in. depending on input voltage.



Servo control signal generator, used to test and familiarize oneself with their normal operation. The 1.0-2.0 mS pulse timing can be measured with an oscilloscope or for 90° operation of a servo. Battery power is recommended as most AC supplies will cause servo jitter.



SERVO CONNECTOR WIRE CODING & PIN SEQUENCE



WIRING SEQUENCE FOR VARIOUS BRANDS OF R/C SERVOS

(1) AIRTRONICS STANDARD: 1 — Black, Signal; 2 — Black, Negative; 3 — Black/Striped, Positive.
(2) FUTABA: Left — White, Signal; Center — Red, Positive; Left — Black, Negative.
(3) AIRTRONICS "Z," HiTec, Tower: Left — White; Signal, Center, Red; Positive Right, Negative.
(3) JR: Left — Orange, Signal; Center, Red, Positive; Right, Brown, Negative.

force a servo in this manner.

CONNECTIONS

The radio control servo requires only three connections: the battery positive, the control pulse, and a common one. There is some variation in the wiring sequence and colors, an example is given in the accompanying sketch.

Don't rely on wiring information or little else obtained from the young kids who often man the counters at hobby shops. Contact the servos maker if any doubt exists. As you might expect, reversing the power connections will harm a servo's electronics same as they will any other electronics device.

REVERSING THE ROTATION

In some applications, it is desirable for the servo to operate in the opposite direction. Obviously, one way to accomplish this is simply to reverse the direction of the control pulse changes. If this is not possible, it can be accomplished at the servo itself.

To do so, it is necessary only to reverse the two wires to the motor, and the outside connections to the pot. The latter's center connection is left untouched. Changing the motor connections is easy in many cases, as they are made with small wires.

However, in other cases, the motor is attached directly to the PC board, with a third connection for ground to the motor case. In that case, it is first necessary to remove the motor.

Many have a case grounding strap that snaps onto the rear end of the case and can be easily remove and installed on the opposite side. Upon replacing the motor back on the board, the power connections will be reversed.

TAILORING THE THROW

Similarly, the throw, that is, the degree of rotation of the servo's output, can be increased by increasing the variation of the pulse length. However, remember the internal stop mentioned earlier! That, and the fact that the feedback pot both also has a mechanical stop limits the total rotation. In some servos, there is a limitation within the amplifier, as they get unstable with travel over 200°, though 180° have been easy to obtain with every one I have ever tried.

If your control pulse is fixed at the 1.0 to 2.0 mS rate, it is still possible to extend the servo travel. It is necessary only to pad the pot with fixed resistors, one at each end.

There is no ballpark figure; the value is determined by the exact servo in use and by your requirement. However, the resistor value is easy to obtain: add a 5K pot to each side of the installed pot, starting with it set at zero resistance. Slowly add resistance, equally on both sides, until the required effect is obtained.

Remove and measure the pots, install fixed resistors of the proper value in place.

SERVO DRIVERS

When working with servos, unless you have used and are thoroughly familiar with your power and pulse-generating equipment, it is a good idea to have on hand a drive system you can depend on. They are also available on the R/C market, intended primarily for use during servo installation independent of the radio system. Recommended are units from:

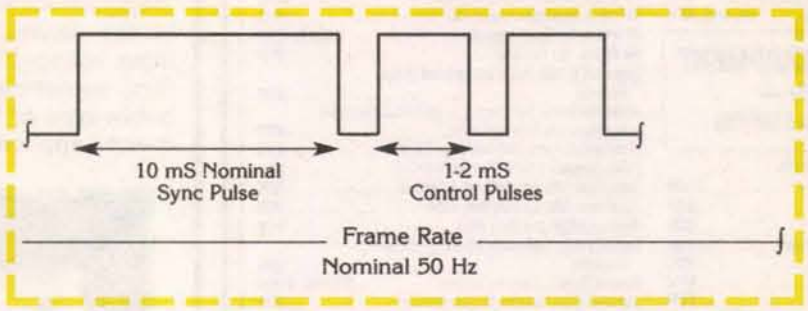
Custom Electronics, RR 1 Box 123B, Higginsville, MO 64037; (816) 584-6284, (816) 584-6285 FAX. Two drivers are available, one with a non-centering knob, though a more useful one for the uninitiated is its "JS" version; joy stick equipped and calibrated for the proper pulse lengths. It is powered by four "N" size alkalines (not included), and is priced at $34.95 less connector, $37.95 with a connector to match your servo. Also available is a universal plug, fittings, and the proper crimper.

ElectroDynamics, 31185 Schoolcraft Rd., Livonia, MI 48150; (734) 422-5420, (734) 422-5338 FAX. Its unit is called the "Servo-Ciser," is calibrated for proper servo travel, uses push buttons for directional control, and LEDs to indicate the degree of movement from center, in 33% increments. It also incorporates an automatic cycling function which will run the servo back and forth for testing purposes. The Servo-Cisor requires an external normal R/C four-cell battery for power. It is priced at $44.95. A simple servo tester circuit, based on the ubiquitous LM-555 is included, for the more ambitious among you.

TROUBLE-SHOOTING

Radio control servos are extremely reliable, but like everything else, now and then one acts up. There are only a few things that can be done if one does. Obviously, normal troubleshooting pro-

Able to move mountains! Well, almost, the PS-105 from Condor R/C has a starting torque of 5278 oz.in., measures 5.12 x 2.17 x 4.37" at 28 ounces. It is available in 12 and 24 volt versions, normal and high speeds, 90 or 180° travel.



Information train as generated by the radio control system for servo operation. The control pulses center at 1.5 mS, drive the servo when varied plus or minus .5 mS. There is a control pulse, designated as 1, 2, etc., for each servo in the system. If only one servo is to be commanded, the sync pulse is not needed.

cedures are called for: Is it getting power and a control signal? Then look for loose or broken connections.

Erratic, non-smooth operation is due to either defective gears or a worn or dirty feedback pot. In either case, replacement is called for.

A completely dead servo can be traced to one of two things: the motor or the amplifier. The former can be tested by disconnecting one side of it and applying five volts; the results are obvious. If the motor runs, about the only thing left is a visual check of the amplifier.

Most of its circuitry is in a proprietary IC, though, in most cases, you will find external drive transistors. Other than checking them, there is little else to do. It is time for a trip back to its parent company.

THE BIG ONES!

Though not actually intended for or used in the radio control hobby, there are a couple of interesting servos available that operate in the same manner, except for input voltage. They can and are, in fact, sometimes operated with a hobby-type of R/C system, finding many applications in robotics, UAVs (Unmanned Aerial Vehicles), etc.

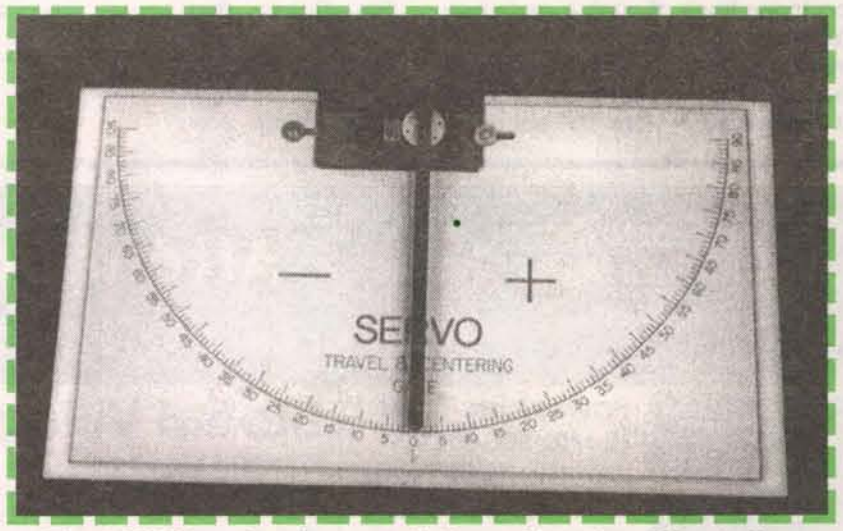
They are the PS-050, and PS-105; see the photos for size information. The 050 is rated at 907 oz.in., at a speed of 0.29 for 60° with six volts input, increasing to 1271 oz.in., speed being 0.21 seconds with 8.4 volt power.

The 105 — the Godzilla of servos — is rated at 5278 oz.in. of torque at a speed of 0.9 seconds for 60°. It is available in both 12 and 24, normal and high speed, and even 180° versions. Except for the input voltages, both servos are controlled by the same control signal as their smaller siblings.

These Big Ones are available in the US only from **Condor R/C Specialties**, 1733-G Monrovia Ave., Costa Mesa, CA 92627; (714) 642-8020, (714) 642-8021 FAX. Check with them for current pricing, availability, and complete specs.

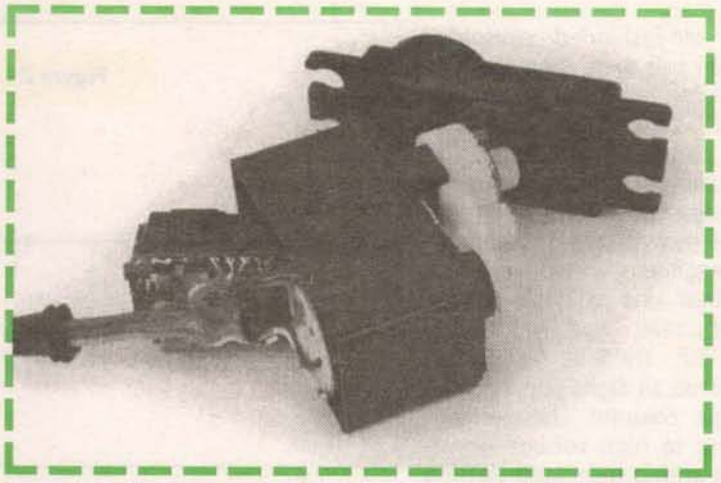
AVAILABILITY

Like so much of our country's electronics, most R/C equipment comes from somewhere in Asia, Japan, Korea, Singapore, Taiwan, etc. It is imported by literally dozens of companies, some of which sup-

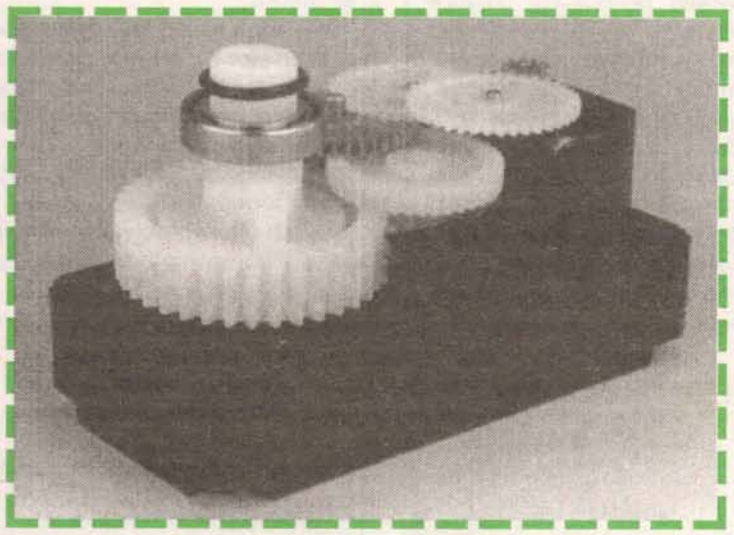


The RCM Magazine (see text!) Servo Travel and Centering Gauge is useful when evaluating, adjusting, or matching servos. Available from them (P.O. Box 487, Sierra Madre, CA 91025), Plan No. 702, $6.00. Shipping is $4.00, folded in an envelope, $7.00 rolled in a tube.

Though looking pretty much like all other servos, JR's "Super Servos" and Multiplex's MC series use a micro-processor to increase the control pulse rate, increasing power and speed.



There are difference one from another, but all servos contain a gear train, motor, and amplifier. The gear-driven feed-back pot mentioned in the text is hidden under the amp.



The gear train in even the standard R/C servo is extremely precise, molded in reinforced nylon in most cases but also available in hardened metal in some cases.

ply complete R/C systems, others only aftermarket add-ons such as servos. The major systems suppliers are:

Airtronics, Inc., 1185 Stanford Ct., Anaheim, CA 92805; (714) 978-1895, (714) 978-1540 FAX.

Futaba Corp. of America, 4 Studebaker, Irvine, CA 92618; (949) 455-9888, (949) 455-9899 FAX.

Hitec RCD, Inc., 107 Wheatlands Ave. Ste. C, Santee, CA 92071; (619) 258-4940, (619) 449-1002 FAX.

Horizon Hobby Distributors (JR Systems), 4105 Fieldstone Rd., Champaign, IL 61821; (217) 352-1958, (217) 352-2010 FAX.

The following offer proprietary equipment of their own, as well as retailing that of some of the others above:

Hobby Shack, 18480 Bandilier Circle, Fountain Valley, CA 92728-8610; (714) 963-9881, (714) 962-6452 FAX.

Tower Hobbies, 1608 Interstate Dr., Champaign, IL 61820; (800) 637-6050, (800) 637-7303 FAX.

Considerably more information is as near as your Yellow Pages — and the nearest hobby store. Obtain for yourself a copy of *Radio Control Modeler Magazine* in which you will find listings for all major and minor servo and related equipment suppliers.

TECHNICAL INFORMATION?

Bear in mind that this — like most consumer electronics equipment — is intended to be installed and used in a specific manner, and support information for the tinkerer is not always available. Unfortunately also, while you can talk to a salesperson all day long, you can not always reach someone with technical knowledge.

From personal experience, I know that Airtronics, listed above, is the exception. They will provide technical support and even schematics if required. I really do not know about the others, my comments are general in nature.

I am available for help that you may not be able to obtain otherwise at: 2626 Northwood, Santa Ana, CA 92794; (714) 540-4935 Phone & FAX.

Wanna go flying? **NV**

Open Channel

by Joseph J. Carr

AC Power Line and Electrical Device EMI

Power lines are regulated as incidental radiators under Part-15 of the Federal Communications Commission (FCC) Rules and Regulations. This means that they will incidentally generate EMI, rather than produce it as a normal part of their operation.

Power lines are supposed to be clean and trim ... right? Wrong, not by a long shot! Power lines are as "dirty" as you please ... perhaps dirtier.

A number of different conducted sources interfere with equipment through the power lines. There are brown outs (when voltage sags to 95 volts in the USA and Canada), and surges (when the voltage increases to 135 volts). Lightning causes its share of havoc, as do ordinary switching transients.

In a medical center, we once flunked the entire freshman class of medical students on their standardized physiology exam. Also failed were all of the basic sciences (i.e., PhD) students and allied health students (e.g., nurse anesthesia, nurse practitioner, physicians assistant). Those people are about "up-to-here" with stress their first year in medical school so the professors hoped that the results would not get out until we solved the problem. It turned out to be power line noise.

In those days, computing was mainframe computing. The examination was taken on "mark sense" optical scanner paper. You know the stuff ... "use a No. 2 pencil and completely blacken the desired box." In our case, the optical scanner was connected to a keypunch machine. To younger readers: A keypunch was a noisy, clunky machine that looked like a typewriter on steroids that punched the holes in old-fashioned computer cards. The cards were then taken to the computer center for processing overnight. When the computer print-out paper was returned, the grades were recorded (manually!) and the paper posted for all to see. The problem was solved when one of the engineers I worked with noticed that one column on the computer card had all digits punched out. There is no EBCDIC code that has all digits punched out in a single column! The problem was traced to high voltage power line transients arising from load shifting switching gear in the basement. It seems that the local power company gave the university a two-percent break on the electric bill if they installed equipment that would periodically balance the load between the three phases (which makes for more efficient operation). Unfortunately, the TRIAC switches tossed huge (>2KV) transients that averaged 50 to 100 microseconds.

The solution to the problem (we couldn't rewire the building or turn off the load switchers) was to place a Topaz isolation transformer between the power line and the optical scanner and keypunch machine. These transformers are specially designed to snuff power line noise (today, we might use a computer surge suppressor for many such applications).

We then found that the noise was the basis for a lot of problems. For example, the electron microscope guy had been attempting to find a "vibration problem" in his equipment (it didn't help that the subway ran right beneath our building foundation ... so he was tuned in on "vibration problems"). Adding an isolation transformer to his equipment cured the little glitches that were

Figure 2

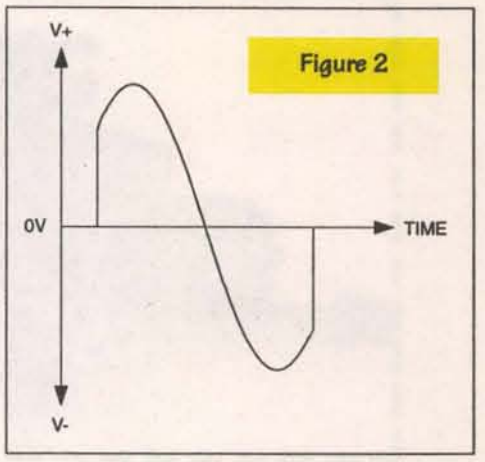
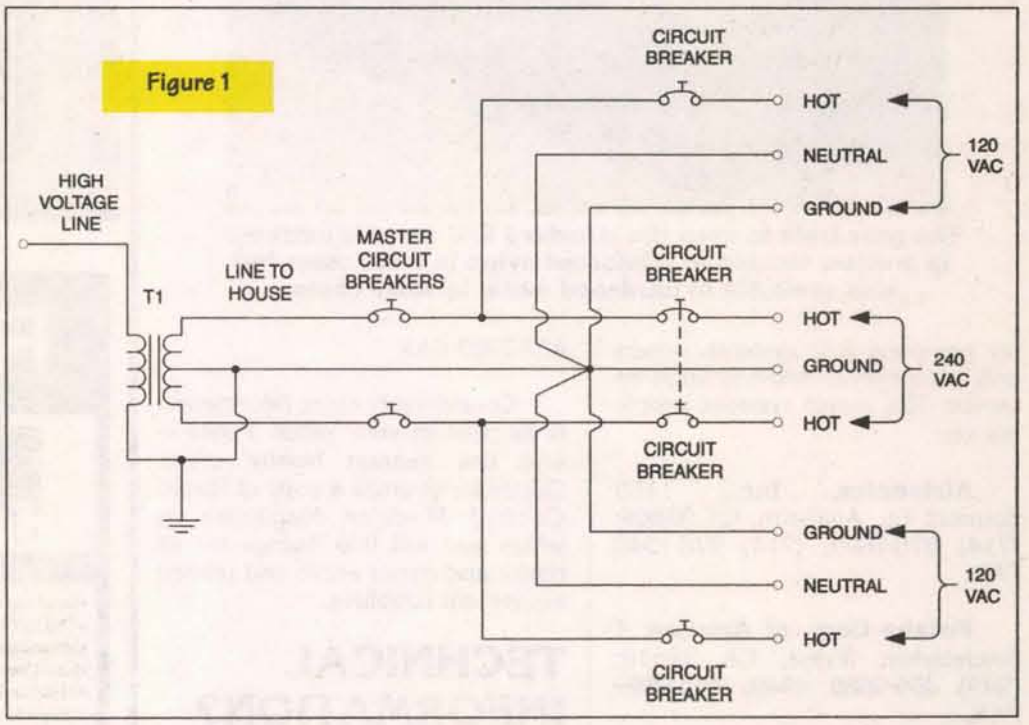


Figure 1



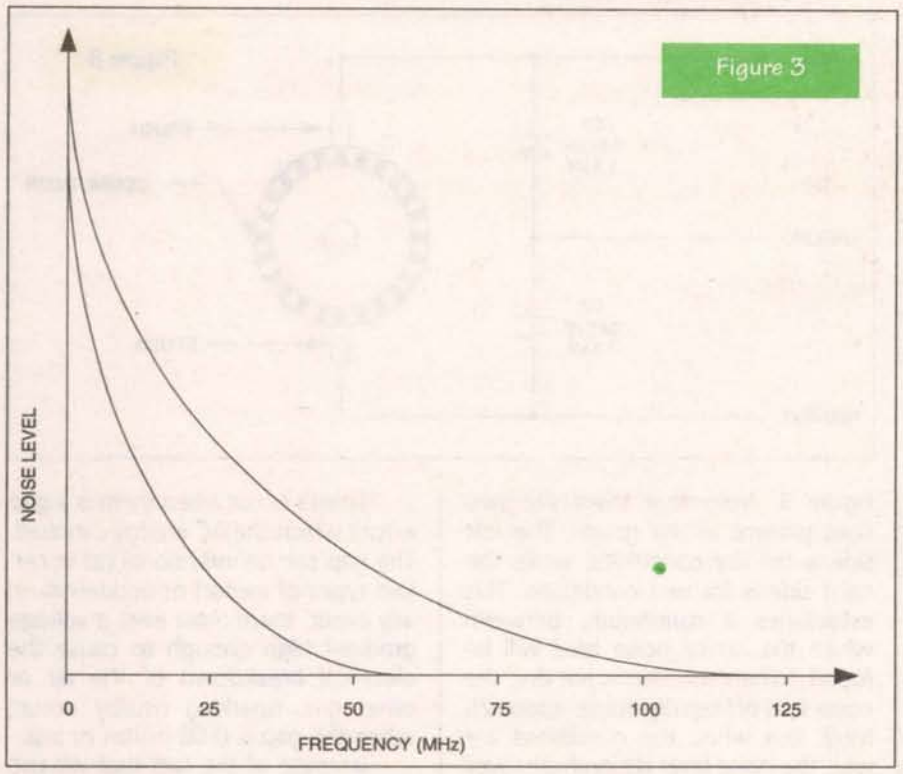


Figure 3

showing up in the pictures he took.

Still another guy was almost comical. He was a hematology researcher, i.e., he knew more about human blood than anyone else. He had a high priced microscope that had a special light source. It was a glass tube that had been evacuated, and then refilled with a special combination of rare gases that each gave off a different color light when ionized. There were about a half dozen electrodes on the tube that each had to see a different voltage. The poor guy had to spend 45 minutes (anytime he wanted to use the microscope) balancing the voltages on these interactive electrodes ... it was a touchy thing, I suspect. Once in awhile, usually (as Murphy's law dictates) when he could ill afford the time, a power line transient would commutate the tube, extinguishing the light. After cursing and yelling at his Graduate Research Assistant (GRA), he would spend another half hour to 45 minutes re-doing the job. When we gave him an isolation transformer, it solved both his technical problem and the GRA's blood pressure problem.

The standard for digital equipment today is to withstand the ANSI standard pulse of 20 µS and 2-kV. Beyond that point, we have to provide a little magic of our own.

120/240 Volt Electrical System

The standard 120/240 volt electrical system is shown in Figure 1 (this is for the USA and Canada, other countries will differ). Transformer T1 is the "pole-pig" transformer outside of your house.

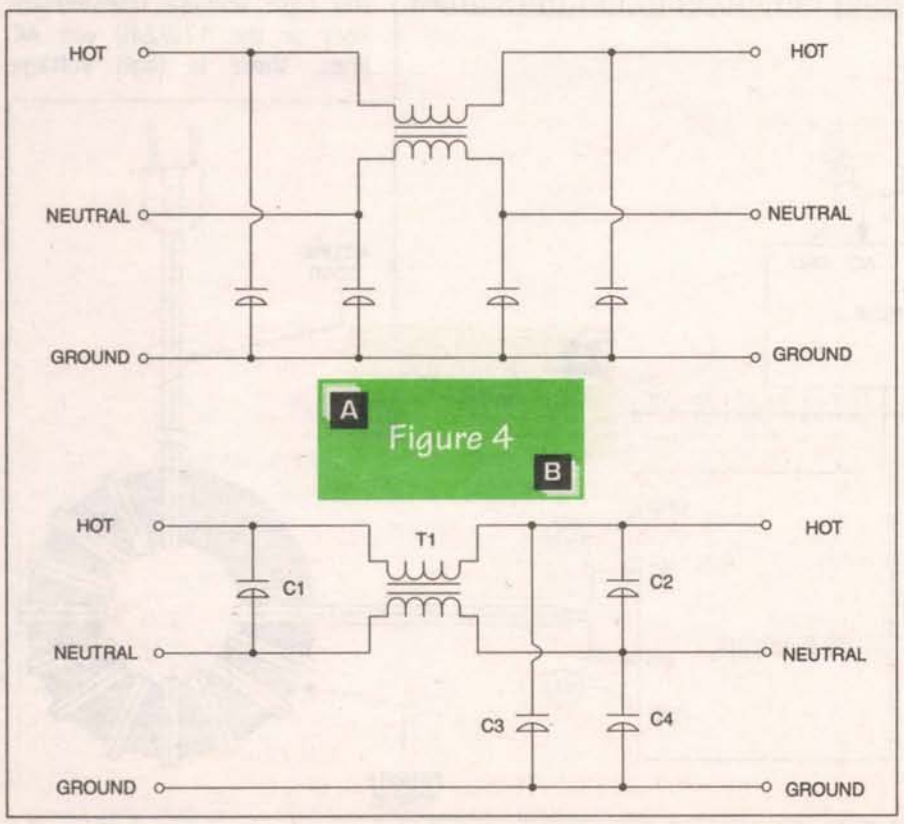


Figure 4

The purpose of that transformer is that it reduces the high voltage that the power is transmitted under to 240-volts AC center-tapped. Three wires are brought into the house where they encounter a pair of Master Circuit Breakers (which may be breakers or fuses). From there, the circuits branch out.

The 240 VAC circuit is used to run heavy appliances (dryers, stoves, air conditioners, etc). It is operated across the two hot lines and has its own set of circuit breakers. A ground wire is provided to keep the circuit safe.

One 120-VAC circuit is provided from each side of the transformer making two independent circuits. Each circuit has its own circuit breaker.

The independent circuits are used separately, but there is some interaction through the neutral line. Normally, one expects to see the lights on a line decrease in brilliance when a large load (e.g., compressor) comes on. But what happens when the neutral is open? In that case, the lights will become more brilliant when the heavy load comes on. This occurs because the 120-VAC lines are not loaded the same, and as a result of the neutral being open. The high drain of the compressor starting up is in series with the low drain of the light bulb, making for a very unbalanced situation.

Noise

Noise can occur on the electrical system whenever there is sparking or any type of truncated waveform in use. Sparking can exist because of loose tie wires or other hardware in the high voltage end of the circuit. We also see sparking on the 120/240-VAC side of the transformer due to electrical motor commutators, switches, and so forth. Sparking also occurs when there is a fault on the system.

The use of truncated waveforms occurs in TRIAC or SCR circuits when not all of AC waveform is used. Figure 2 shows a truncated AC waveform. The harmonics generated by this scheme are tremendous. Recall that the sinewave is pure, all other waveforms have significant harmonics. Therefore, when not all of an AC waveform is used, harmonics are generated. Light dimmers are examples of such devices.

Regulatory/Legal Issues

Power lines are regulated as incidental radiators under Part-15 of the Federal Communications Commission (FCC) Rules and Regulations. This means that they will incidentally generate EMI, rather than produce it as a normal part of their operation. The Rules and Regulations regarding incidental radiators say the device shall:

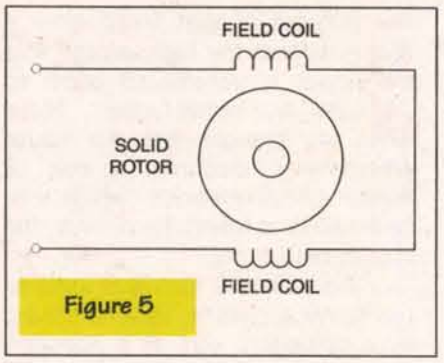


Figure 5

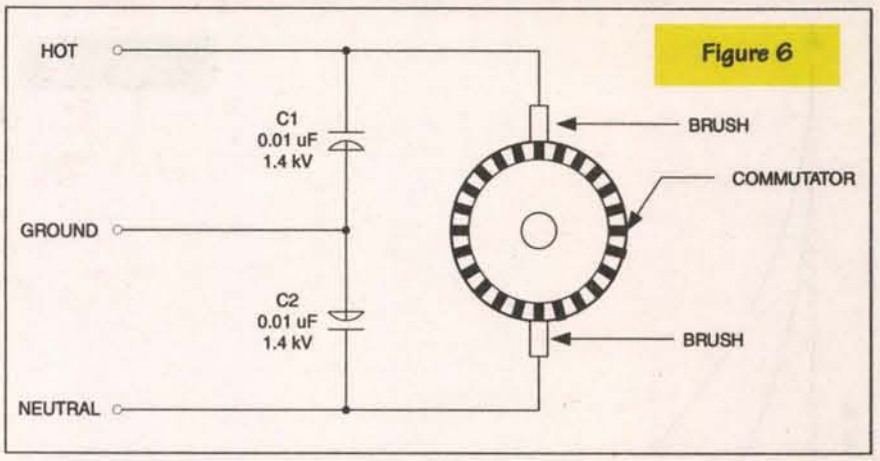


Figure 6

1. use good engineering practices and
2. shall not cause harmful interference

The operator of an incidental device shall cease operating upon notification by the FCC, and shall promptly take steps to ensure that operation of the device does not cause interference. That sounds like strong language, but there is a hidden argument. The argument hinges on the definition of "harmful interference." What is harmful in one case, might not be harmful in another.

As a result, there are no absolute limits that the power company must meet. And electrical power is necessary in modern society, so there is a built-in bias against turning it off. The FCC uses cost, the number of people involved, severity of interference, and a host of other factors to determine whether or not to get involved. In general, it is wise to try troubleshooting the problem yourself before involving the FCC.

Corona and Spark

The interference caused by power lines can be due to corona or sparking. Corona is "... a partial breakdown of the air that surrounds an electrical element such as a conductor, hardware, or insulator." A corona discharge is often visible, and will be a pale blue light around the conductor. A voltage gradient must exist between two different points such as the conductor and ground. As a result, you will see corona discharge around 7.5 kV lines, but they are more common with 230 kV lines.

The frequency components of corona discharge EMI is shown in Figure 3. Note that there are two lines present in the graph. The left side is for dry conditions, while the right side is for wet conditions. This establishes a continuum, between which the actual noise level will be found. When conditions are dry, the noise falls off rapidly above about 25 MHz, but when the conditions are wet, the noise level is significant well into the VHF spectrum. It can affect up to the lower VHF TV channels, the FM BCB, and even some of the aviation band. The corona is generally restricted to 1,000 yards from the power line.

Sparks occur when there is a gap across which the AC energy can leap. The gap can be intentional (as in certain types of motor) or accidental. In any event, there must exist a voltage gradient high enough to cause the electrical breakdown of the air or other gas. Sparking usually occurs when the gap is 0.06 inches or less.

Because of the fact that we use 60 Hz in the USA and Canada, there will be 120 voltage peaks per second. This means that there will be 120 instances per second that are capable of causing noise peaks. This causes a characteristic "buzz" that can be heard at broadband frequencies to 1 or 1.5 GHz. Unlike corona noise, spark noise tends to die off when conditions are wet.

Both spark and corona noise is normally louder close to the power lines, which helps in locating it. Unfortunately, the noise will vary as one tracks along the line, peaking at the point where the noise occurs. This can cause you to misidentify points where the noise occurs.

Safety

Whether you are working with the high voltage transmission lines or the 120/240 volt AC lines, there is high voltage

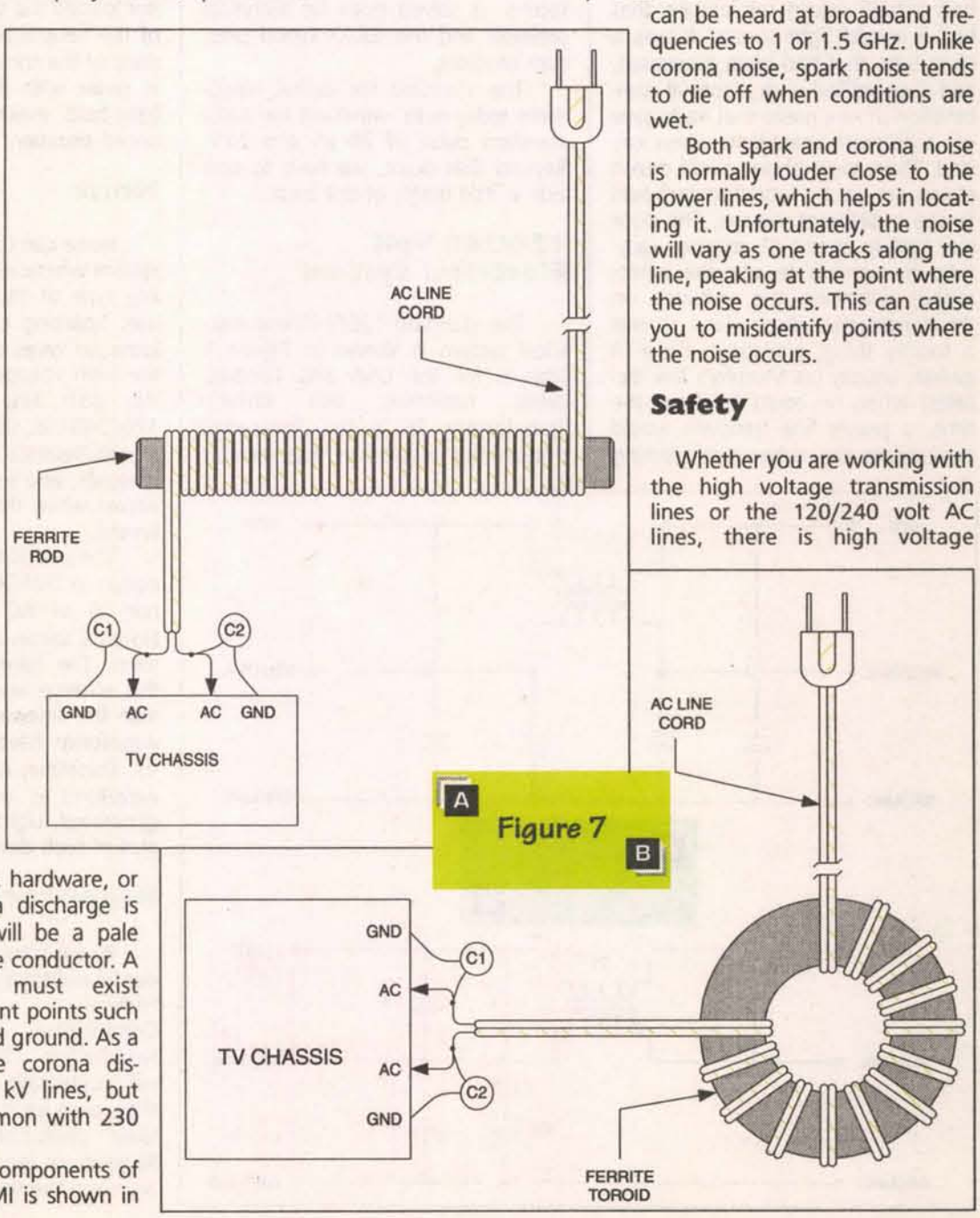


Figure 7

present on the lines. It is essential that you operate in a manner that is consistent with safety when working on those lines. *These lines can kill you ... so don't take any chances.*

Locating EMI Sources

Before attempting to find an EMI source outside the home or business, it is necessary to eliminate sources inside the building. Every device that has a motor in it is capable of generating EMI, so be careful.

Filter Solution

The filter solution works best when the source is at least partially shielded, but will work at least some most of the time. Figures 4A and 4B shows two circuits that can be used to filter AC noise carried on the AC power line. Interestingly enough, these filters can be used on either generators or victims of EMI.

Notice that each of these filters uses a special type of inductor. The inductor is designed as a common mode coil having a single core for the two coils. This is not strictly necessary, but is a highly recommended form of construction.

The capacitors selected are 0.01 µF to 0.1 µF of a type intended for use on the AC line. They will typically have a WVDC rating of 1,400 volts, and will be rated for use in AC circuits. Lesser capacitors (such as 600 WVDC types) will not be able to withstand the peak and transient conditions.

When installing such filters, they should be as close to the offending equipment as possible. This eliminates the wiring to/from the sparking contacts as radiated sources of EMI. Alternatively, when protecting equipment from EMI due to power line conduction, place the filter as close as possible to the point where the power line enters the cabinet of the equipment. There are EMI AC filters available that are built right into the AC plug assembly.

Electric Motors

There are two types of AC motors available: induction (Figure 5) and brush-commutator (Figure 6). Generally speaking, it is the brush-commutator motors that cause the most problems due to the sparking that occurs. Whether vacuum cleaners, electric driers, sewing machines, mixers, or power tools, the brush-commutator motor will cause problems. The fix is to add capacitors such as seen in Figure 6 and filtering. Attempt the capacitors first, and then follow up with filters if that doesn't work.

Common-Mode Filtering

Regardless of whether or not there is filtering or capacitors in the circuit, there should be a common mode filter in the circuit. In fact, rolling up the power cord is the first thing that ought to be tried because it is non-intrusive. Figure 7 shows two versions of the common mode choke installed on a TV set. It could just as easily be installed on any device that generates or is victimized by power line EMI. In Figure 7A is a version using a linear rod, while Figure 7B is based on a toroidal core.

Transients

Transients are (usually) high amplitude, short duration pulses of energy. They are transmitted along an AC line for many miles, resulting in interruption of equipment (especially digital) at your end. They can also be locally generated, as in the scenario at the beginning of this article. The solution adopted back in 1975 was to use a special transformer. Today, however, I would start by using a MOV (metal oxide varistor) device across the AC power line. The MOV device clips the voltage at something over 185 volts, but a lot less than 2,000 volts.

Trip to Ireland, Scotland, and England

This summer, I decided to let the wind out of my head a bit. My wife and I took a vacation to Ireland, Scotland (where we Carr's come from), and England. We flew through London on British Airways (a first class outfit), on to Shannon Airport in Ireland. We then rented a car and drove north about 80 miles to Galway City. It was a real treat watching the sunset on Galway Bay at 10:30 at night (it's that far north). We then drove across the country to County Louth, where we visited a childhood friend of mine for a day.

After visiting with Doug and Anne, we flew on to Edinburgh, Scotland. Don't do Edinburgh in only three days like we did! We also saw Rosslyn Chapel and Ferniehirst (the castle of the Kerr's ... root of the family Carr). After Scotland, we went to England, and Bonnie flew home while I attended the annual symposium of the International Council on Systems Engineering (INCOSE) at Brighton, England. For a few days after the conference, I wandered around England and saw Salisbury Cathedral, Stonehenge, and Glastonbury Abbey. All in all it was a really great trip! **NV**

Connections ...

I can be reached by snail mail at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

reader FeedBack

Dear Nuts & Volts:

The circuit diagram for the return loss bridge (Open Channel, Sept. '99 page 76) is incorrect.

As drawn, T1 imposes a short between the junction of R1-R2 and the unknown impedance (J2). The bridge cannot balance because the legs are unequal. The lower left impedance is R2+Z0 = 2 Z0; all other corners are just Z0.

To fix the circuit, connect the bottom of R2 to ground. Then the bridge can balance: R1 and R2 form the left side; R3 and the unknown form the right side. T1 should be a balun that converts the balanced signal across the bridge to a single-ended output. Disconnect one of T1s bottom terminals from ground and connect it to J3. That completes the fix.

Gerald Roylance, Mountain View, CA

Dear Nuts & Volts:

I have a comment regarding the Tech Forum answer given for #6996. Michael Mruzek's idea for determining frequency of a PTO driven generator using a clock is great. It is simple and uses something that everyone almost certainly has on hand. He should understand, however, that even most electronic clocks can be used rather than just motor-driven clocks.

Electronic clocks almost always derive their timekeeping signal from the line frequency via an AC feed from the secondary of the power transformer. Clocks with battery backup do have an internal oscillator, however, as often as not, it uses a low precision ceramic resonator and is only energized when the power is off. When under AC external power they too use the line frequency as a reference.

David B. Sarraf, via Internet

Dear Nuts & Volts:

Dan North's questions (Sept. '99, Electronics Q & A) about the lightning detector in Joe Carr's column (Feb. '99 Open Channel) were very good, but many of the answers were wrong.

The basic detector is described in Thomas P. Leary's article in *QST* (June '64, page 23-26). If I were back in Boston, I would build one, but we don't get much lightning in Silicon Valley.

The coil is electrostatically shielded to reduce capacitive coupling. Carr states this at the bottom of page 16. The shield has no effect on magnetic coupling. The shields do not, as TJ Byers claims, magnetically isolate the coils. Byers is also incorrect in his claim that without the shield, "the antenna appears as a single turn of wire that has no value in detecting lightning strikes." Without the shield, the antenna will pick up more noise (and be less useful), but the turns in the loop don't magically merge together. Its sensitivity to lightning strikes is undiminished.

The output voltage of the loop is proportional to the number of turns and is also proportional to the area of the loop, but the issue is more complicated than that. The loop antenna can only intercept a certain amount of power, so the number of turns and the amplifier impedance are important.

Increasing the area increases the amount of power the antenna intercepts. Increasing the number of turns does not increase the power (but it does affect the impedance match).

For a typical configuration, the amplifier input impedance should be small to match the small impedance of the loop antenna. The 10M input of your scope is too high; it allows a lot of thermal noise. One saving grace is that lightning has a lot of power, so even an insensitive 10M scope might see a strike. Leary's amplifiers were high impedance, and he got results.

Grounding one end of each coil will not hurt the sensitivity. Several authors have made claims about keeping a loop antenna balanced, but I'm suspicious of these claims because they don't say why. Using a balanced/differential configuration is a good idea because it forces the builder to pay more attention to ground noise, but I don't think it is essential.

Reversing the coils does not "null out the signal altogether." Reversing the coils just mirrors the axis on the scope display. The *QST* article discusses how to connect the two antennas to align the north-south and east-west directions. The antennas are in quadrature and cannot null each other out. They will only null if they are in the same plane and connected in opposition (so the turns cancel).

The Z-input does not provide directionality "because of the cardiod pattern of the antenna." The crossed loop antenna is omni-directional in the horizontal plane. A signal arriving from an angle theta will generate a cos(theta) signal in the NS loop and a sin(theta) signal in the EW loop.

The length of signal displayed on the scope is independent of the angle. There is no cardiod antenna pattern. The Z-input detects the electric field. The loop antennas detect the magnetic field. Looking at both the electric and magnetic fields lets us sort out the direction the wave travels.

Electromagnetic waves have a handedness, and the electronic storm finder uses the E field to gate the M field detectors (the two loops antennas). If you look at a drawing of an EM wave you can get an idea of how this works. Unfortunately, the details get in the way. The loop antennas introduce a 90-degree phase shift. Leary compensated for this phase shift by putting a 90-degree phase shift in his Z-axis amplifier (but his circuit has problems).

Carr's column omits the Z-axis amplifier and ignores the phase shift issue. (Some radio direction finding (RDF) antennas use both E and M antennas, and the tuning instructions include adjusting the phase shift to 90 degrees.) Without the phase shift, the Z-axis gating does not work.

Thanks for the intriguing article about detecting lightning. It made me think about many interesting things. Both Carr and Byers have many interesting things to say.

Gerald Roylance, Mountain View, CA

Dear Nuts & Volts:

Thanks for the Tesla Coil article in the Sept. 99 issue. This is a project my 10-year-old son and I have been talking about for the past couple of months. Ever since he garbage-picked fluorescent tubes and as he and his buddies escaped on their bikes, they passed under a high-voltage line. In an instant they "got religion" when the lights started to flicker in their hands in the gathering dusk. My son, who loves to experiment with electronics, figured it out after a few incredulous minutes and started the boys riding in circles under the wire. As darkness fell, I am sure they

Continued on page 63

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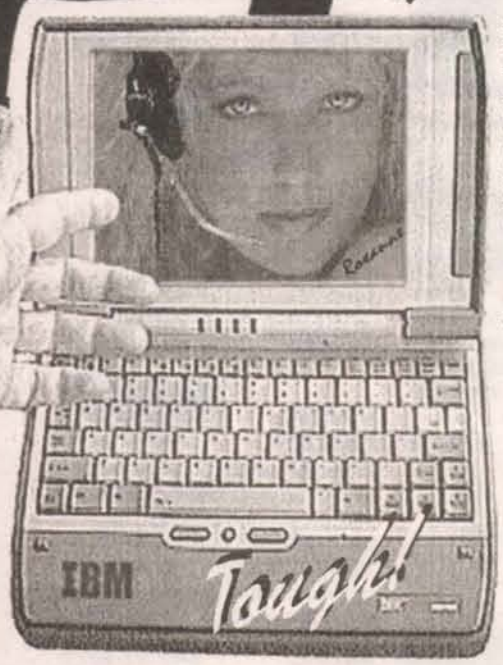

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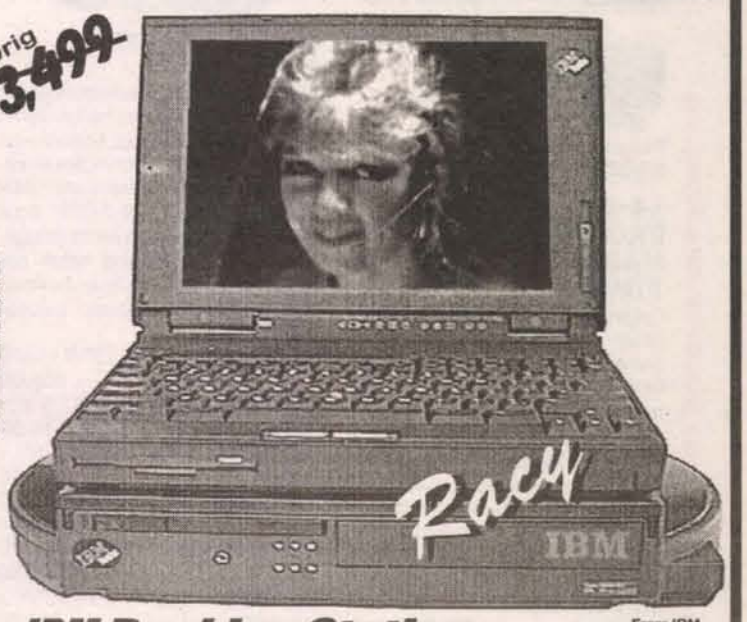

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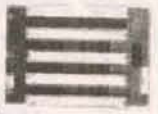

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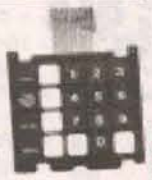

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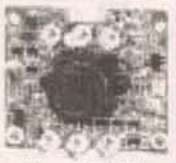
97B014 99¢ each



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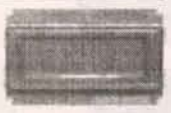

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by Thomas Henry

Build a Tunable Noise Generator

Electrical noise is most often considered an enemy.

This article describes a tunable noise generator which, instead of using an active filter, employs FM (frequency modulation) to obtain a broad range of sounds.

In audio and radio circuits, for example, it can lead to an annoying background hiss or distorted reception. But, in fact, noise can be useful in a great number of applications. For example:

- A medical researcher might use it to study ways of reducing ringing in the ears, a condition known as tinnitus.
- An audio technician can use white noise to equalize a public address system (set the tonal balance) for a particular room.
- An electronic musician uses noise when synthesizing percussive instruments like snare drums.

In these and other situations, we need a reliable source of noise. Now by definition white noise — as it is often called — is a completely random mix of all frequencies, just as white light is a blend of all colors. On the other hand, pink noise is similar, but more emphasis is given to the frequencies within the audio band. It's possible to carry this even further and create other types of noise by emphasizing or shunning various frequencies. This is usually done by following a white noise source with an active filter whose cutoff frequency can be adjusted. The filter can quickly become quite complicated and be touchy to adjust.

But, in fact, noise can be useful in a great number of applications.

But here's a new approach to the problem. This article describes a tunable noise generator which, instead of using an active filter, employs FM (frequency modulation) to obtain a broad range of sounds. What comes out of it is noise, of course, but it's possible to emphasize certain bands of frequencies.

When sweeping it over its range, the effect is quite ethereal, a sort of "swooshing" not unlike the sound of wind whistling through forest trees. Let's investigate the general procedure first before turning to the circuit itself.

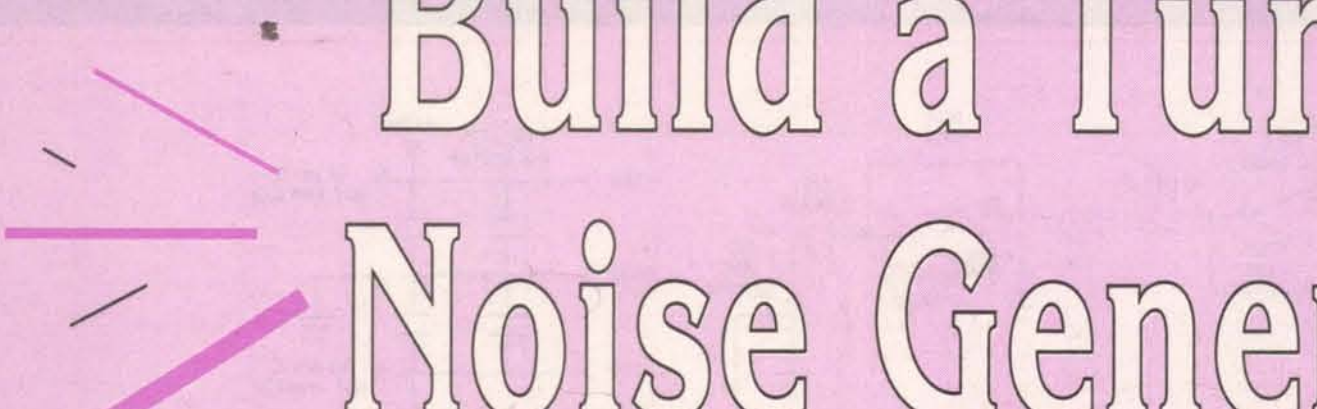

FIGURE 1

A Tunable Noise Generator: Block Diagram

PRINCIPLE OF OPERATION

Figure 1 shows the block diagram of the tunable noise generator. First, white noise is created using standard techniques which then modulate the frequency of a VCO (voltage-controlled oscillator). The depth control is used to set the amount of modulation desired. A separate tuning control adjusts the center frequency of the VCO. The modulating white noise, then, causes the VCO to vary randomly from this center frequency. In this way, a certain tonality is imparted to the sound thus created; it's still noise, but it seems to be focused around a certain band of frequencies. By twisting the tuning control, it is possible to sweep the sound across the entire audio spectrum.

Incidentally, a VCO with a triangle wave output seems to work best here, giving a fairly smooth sound. Squarewaves, on the other hand, lead to a rather harsh and gritty effect. In any case, the output of the VCO is dropped across the volume control which lets you set the amplitude.

So we have arrived at a unique method for "tuning" the response of a noise generator without requiring the use of active filters. Let's check out a practical circuit which implements the block diagram of Figure 1.

HOW IT WORKS

Refer to Figure 2 which shows the schematic for the tunable noise generator. Let's start out by analyzing the white noise source first, leaving the VCO portion for later. Notice the unusual arrangement of transistor Q1. The collector isn't used at all, which suggests that Q1 is being pressed into service as a diode. In fact, it's really behaving as a zener diode since the base-emitter junction has been deliberately reverse-biased. Observe that the emitter has been tied high through R18, while the base connects to the negative side of things. Thus, the transistor is straddling a full 30V (+15V and -15V) which is enough to overcome the base-emitter breakdown voltage. This forces it into avalanche mode and produces a really decent source of white noise at the emitter. R18 limits the current flow through the transistor, so that it doesn't fry in the process.

R18 also acts as a load resistor for the noise thus generated. Unfortunately, the signal is a trifle weak just now and needs to be boosted. So, we send it to a preamplifier configured around IC1a, AC coupling it in the process by means of capacitor C6. Notice that C6 is purposely kept fairly small so that the bass frequencies will be attenuated a tad. This helps prevent rumbles in the sub-sonic region.

R1 and R13 set the gain of op-amp IC1a to a factor of 101. But believe it or not, that's still not enough "oomph" to properly modulate the VCO yet to come. So we move on to yet another preamplifier, this time comprising IC1b, R4, and R14. Operating in inverting mode now, this op-amp will have a gain of 10. Put the two preamps together, and we have boosted the white noise by a factor of over 1,000. Now it's strong enough to do what we require of it!

The hefty noise available at pin 7 of IC1b may have accumulated an unwanted offset, so we AC couple it to the next stage via C8. The full strength signal is applied across potentiometer R9, which lets you manually adjust how deeply the noise will modulate the VCO.

And speaking of which, let's look into the VCO now. It was

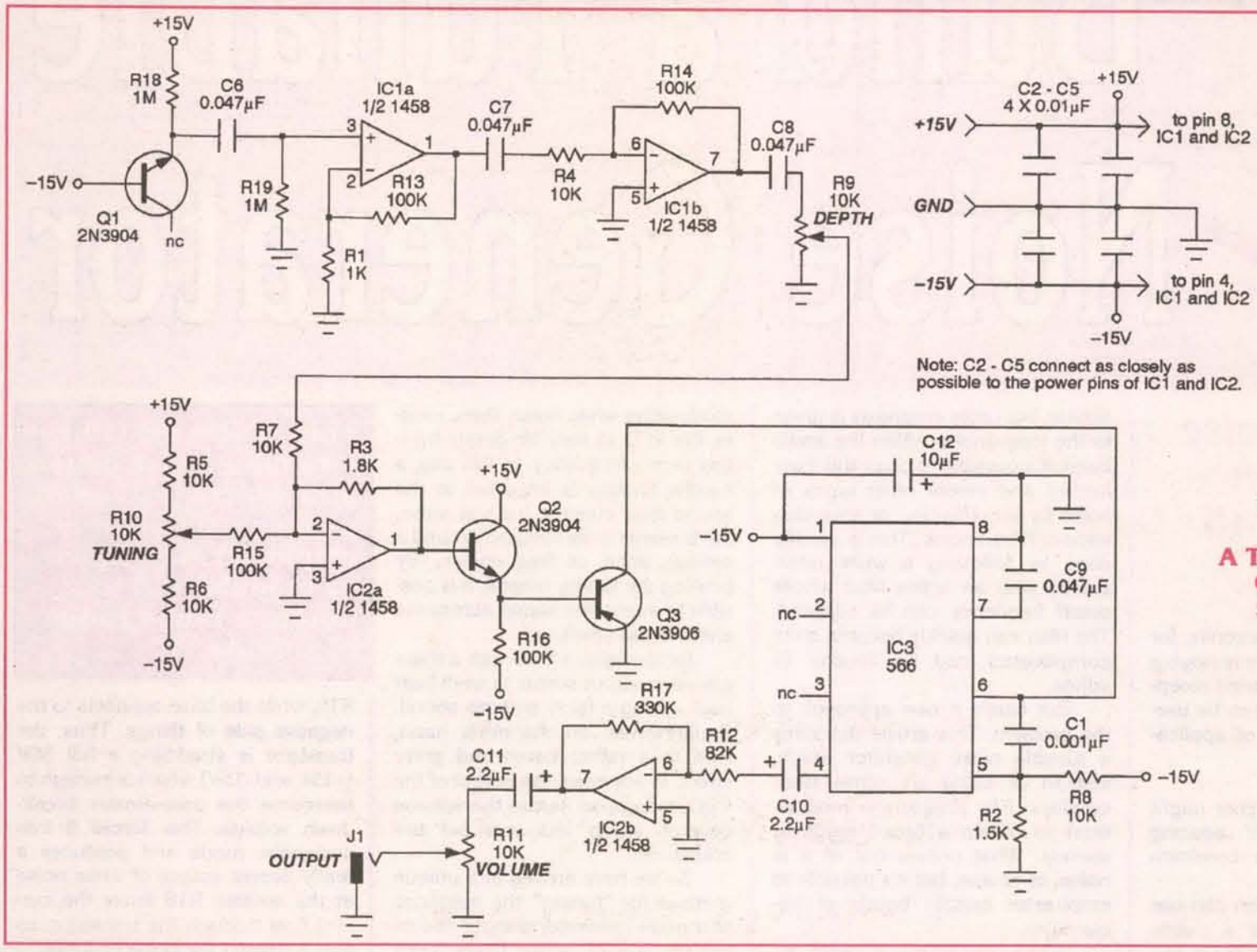

FIGURE 2

A Tunable Noise Generator: Schematic

designed with several important factors in mind; let's overview them before getting into the circuit details.

First, after much experimentation, it was determined that, for best results, the frequency sweep range should be at least 1000:1. Next, to make the device more suitable for audio and musical work, a 1V/octave exponential response seemed appropriate. (Each increment of 1V at the control input should cause the VCO to jump up an octave.)

By pulling some clever circuit stunts, we can coerce the 566 VCO chip (which is both common and cheap) to do exactly what we require.

Finally, the design had to be carried out with easy-to-find and inexpensive parts.

The last criterion may seem to be the hardest to overcome, since exponential VCO chips are a rarity nowadays. But here's the surprise: By pulling some clever circuit stunts, we can coerce the 566 VCO chip (which is both common and cheap) to do exactly what we require. Now, as it comes from the factory, this chip responds to a linear control voltage, which has an extremely limited sweep range of 10:1. However, with the addition of just a few garden variety components it is possible to trick the 566 into thinking it understands the exponential language. The approach taken hinges on two basic ideas:

- We can get better control over the 566 by ignoring the linear control voltage input, and throttling the current which charges and discharges the timing capacitor instead.
- The collector current of a bipolar transistor is exponentially related to the base-emitter voltage.

So, we'll whip up an exponential converter based upon the transistor characteristic mentioned above, and let that current directly govern the charge/discharge cycle of the timing capacitor.

That's the general idea. Now let's get back to specifics by examining Figure 2 in more detail. The first thing you'll notice is that the power supply connections to IC3 — the 566 — seem a little weird; -15V and ground (instead of the usual ground and +15V) connect to pins 1 and 8, respectively. Of course, from the 566's point of view, this makes no difference since there's still a +15V differential across pins 1 and 8. The reason we take this unusual tack will become clear in just a moment, so let's continue.

As mentioned above, the linear control voltage input at pin 5 is too seedy for our purposes, so we'll simply bias it at a fixed value and leave it there. The bias is determined by voltage divider R2 and R8. By the way, C1 is nothing more than a simple compensation cap which keeps the sensitive linear input from breaking into spurious oscillations.

Capacitor C9 sets the basic operating range of the VCO. On the other hand, the current fed into pin 6 sweeps the VCO's frequency up and down. And now we can see the reason for the somewhat exotic power supply arrangement.

The exponential converter — to be described next — is a current source and pin 6 of IC3 is a current sink. Voila — an exact match! (Had we employed the usual power supply arrangement, both the exponential converter and the 566 would have been current sources.)

Let's see how that magical exponential converter works. Recall that linear changes in the base-emitter voltage on Q3 will cause exponential changes in the collector current which feeds IC3. The base of Q3 needs to be driven by a low impedance source, so Q2 acts as a simple emitter follower. More importantly, the two transistors tend to act in harmony to reduce VCO frequency variation caused by temperature changes. (The theory of this can get pretty complicated in a hurry, but the basic idea is that if the emitter saturation currents of the two transistors are reasonably close to each other, then temperature dependence is reduced.)

All of the components are commonly available, and there's nothing particularly tricky about the construction.

There are a couple more details to consider, then we'll have this exponential converter under control.

First, when Q2 and Q3 do their thing, the response from the VCO will be "backwards;" the smaller the input voltage, the higher the frequency. Moreover, the scaling factor of the converter isn't quite right. It can be proven via some rather

tedious calculations that the VCO frequency will double for every 18mV decrease at the base of Q2. (Recall that we want a 1V/octave response, i.e., a doubling for every 1V increase.) Both of these problems are easily dispatched by IC2a.

First of all, notice that this has been set up as an inverting amplifier. That takes care of getting the sense of the control voltage correct; an increasing voltage at the input leads to an increasing frequency of the 566. Also, the ratio of R3 and R15 set the gain of IC2a at about 0.018. So, when the input changes by one volt, the output of the op-amp changes by 18mV, as required.

R15 is driven by the wiper of R10, the tuning potentiometer. The top and bottom ranges of this control have been limited appropriately by R5 and R6, respectively. With this pot you can sweep the VCO's basic frequency from about 20Hz to 20KHz in one fell swoop; there's lots of usable range here!

But here is the key to the whole circuit. Recall that the white noise generator output can be picked off the wiper of R9, the depth control. This signal feeds R7, which then sums into IC2a. Thus, the noise modulates the basic frequency of the VCO, completely at random. Potentiometer R9 lets you adjust how much modulation you want. Naturally, when set to zero, the circuit performs as a normal VCO.

And that brings us up to the output of the entire circuit. There are two waveforms available from the 566 chip, a squarewave (pin 3) and a trianglewave (pin 4). Feel free to use either waveform, but in general, the triangle output sounds quite a bit smoother. But note that pin 4 rides on a rather heavy DC bias which needs to be blocked, and the amplitude of the triangle there is only about 2.4Vp-p. Capacitor C10 AC couples the signal to op-amp IC2b, which then boosts it up to about 10Vp-p. The output is applied to volume control R11, which can tame the signal as desired before it finally appears at output jack J1.

BUILDING THE TUNABLE NOISE GENERATOR

Checking out the Parts List makes it clear that this would be an easy and inexpensive weekend project. All of the components are commonly available, and there's nothing particularly tricky about the construction. You can build it using just about any method, from breadboards to wire wrap to printed circuit boards. For best temperature stability, though, be sure to mount Q2 and Q3 so that they're touching each other. You might even want to epoxy them together. And be sure that the wiring around the two transistors is neat since some rather low currents are involved.

When using the tunable noise generator, be careful not to blow out either your loudspeakers or your ears! The output of this device is pretty hefty (up to a max of 10Vp-p). This higher value was selected so that the circuit would be compatible with analog synthesis equipment. On the other hand, if using the tunable noise generator with standard hi-fi gear, you'll want to turn volume control R11 down to give an output of around 2Vp-p.

Finally, if you're looking for some other uses for the tunable noise generator, be sure to check the Internet site mentioned in the Parts List. You'll find modifications and hints concerning this circuit there. **NV**

ACKNOWLEDGEMENTS

I wish to thank the following two authors whose writings provided key information used in the design of the VCO portion. First, the 566 power supply trick was suggested by John Simonton, in his article, "Potpourri and the Apple Connection," Polyphony, November 1977, pp. 28-31. Next, Terry Mikulic explained the operation of the exponential converter in his article, "Exponential Converters," Electronotes, Volume 5, Number 37, pp. 2-4.

PARTS LIST

All resistors are 1/4-watt, 5% values.

R1	1K
R2	1.5K
R3	1.8K
R4 - R8	10K
R9, R10	10K linear potentiometer
R11	10K audio potentiometer
R12	82K
R13 - R16	100K
R17	330K
R18, R19	1M

All capacitors are 16V or better.

C1	0.001 mfd. mylar
C2-C5	0.01 mfd. disc
C6-C9	0.047 mfd. mylar
C10, C11	2.2 mfd. electrolytic
C12	10 mfd. electrolytic

Semiconductors

Q1, Q2	2N3904 NPN transistor
Q3	2N3906 PNP transistor
IC1, IC2	1458 dual op-amp
IC3	566 VCO chip

Other components

J1	1/4" phone jack

RESOURCE

Modifications, hints, and tips concerning the Tunable Noise Generator are available free of charge on the Web page of Midwest Analog Products.
http://mall.lakes.com/~map
E-Mail: map@prairie.lakes.com

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SPECIAL,CRC-1-STD,.....$119.ea

GRAPHIC LCD DISPLAY, SEIKO Model G191C21R0A0

Like new, G191 series, monochrome with EL (electroluminescent) backlight. These gorgeous FSTN type panels are perfect for direct sunlight applications. They won't wash out! The dot format is 192 X 128. The module size is 98 x 66 x 13.4mm. The viewing area is 76 x 54mm. The dot size is 0.33mm x 0.33mm. Power requirements are +5VDC @ 3.1mA and -12.4VDC @ 2.9mA. The backlight adds 120mA to the +5 current. Weight is 3.6oz. The viewing angle is 40°. Operating temperature range 0°C to 50°C. Now's your chance to design a really high-tech display into your next project. Data included. These are sophisticated devices, please be sure you are capable of integrating them into your device. Please review data at Seiko web page: www.seiko-usa-ecd.com/lcd/html/graphic/modules/g191c21r0a0.html. All sales final. Current price $111 each. Very Limited quantity. **SPECIAL.....$29ea. or 2 for $49 or 5 for $99**

PARKER-COMPUMOTOR, SM231A BRUSHLESS SERVO MOTOR

New, SM series with optical encoder feedback, (1000PPR). Rated shaft output power is 200 watts. Stall current is 2.1 Amps. Rated speed is 7300RPM. Torque at rated speed: 2.37 lb -in., Shaft diameter 0.25". Full specs are available on the web at: WWW.compumotor.com/catalog/SMseries598.pdf. Size: 4"L x 3.3"H x 2.25"W. These are sure to sell out. Very limited quantity. **SPECIAL.....$149ea. or 2 for $269**

BIO CHEM VALVE CORP. Type 10097-550, Solenoid

check valve. This unique valve has no contact with the controlled substance. It operates be squeezing a 1/8" diam. tubing and thereby "crimping" it closed when activated by 24VDC. The action is normally open. (shown right) Size: 1" diam. x 2.8" L. With 12"L wire leads. Removed from equip.

PREDYNE, MINI VALVE, Type A92037-926, 24VDC @200mA solenoid operated, 5/32" orifice, 8PSI, pass through valve with 1/8" barbed nylon fittings attached. (removeable for screw in connection.) 12" wire leads. (shown left) Removed from equip. Both are like new condition.

BIO CHEM VALVE.....$5ea., PREDYNE VALVE.....$6ea.

NEW, GM960 TIME LAPSE VIDEO RECORDER

Finally a brand new, 4 head, T/L recorder with all the features at a price you can afford. Features: • Up to 960 hours on a standard T-120 VHS tape • 12 different modes for record and playback • Audio recording in the 12H and 24H mode. • 300day memory backup • Easy mode setting • On- screen menus • Auto-Repeat recording mode • Serial or One-shot recording • Time, Date, speed, and Alarm indicators on screen. These deluxe units are front loading and are 14"W x 3.5"H x 12.2"D. 110VAC powered.

SPECIAL.....$699ea. or 2 for $1349

STEPPER DRIVERS, SUPERIOR ELECTRIC, SLO-SYN Type, 3180-PT12S,

These drivers are removed from equipment and in good condition. They are designed for use with an external indexer. We have no documentation for these units. They are a compact 7"x5"x4". We always sell out of these so don't delay! Very limited quantity.

NOW.....$139ea. or 2 for $249

PORTABLE MINI PRINTER, 40 COLUMN, with INTERNAL NI-CAD POWER!

The model SD222-3000 is a NEW and very cool, self contained, alphanumeric, impact type printer. It features a standard parallel port and an internal Ni-Cad power supply. Can also be powered via the 9VDC power adapter supplied. Uses standard 2" wide paper rolls available everywhere. Has self test function and diagnostic mode. Can emulate Epson and Citizen 560. It will print from the LPT port of your PC. Very rugged and well made. Perfect for any remote printing or data logging application. Size: 5"L x 4.1"W x 3.5"H. **OUR PRICE.....$49ea. or 2 for $75**

"A STRANGE LITTLE DEVICE"

AT&T Universal Digital Echo Canceller, Model: ATTNEI20R2-2. If you have a use for this you know they are quite pricey. We have several available. They are like new. Standard 6pin RJ style jack for connection. Give us a call if you know how to use this and get one for free.

AT&T, UDEC.....$89ea.

NEWPORT TRANSLATION STAGES, also a few other goodies too!

MODEL:	DESCRIPTION:	EACH
270	LAB JACK	$249
RSA-2T	360 deg. Rotary Stage with Clear Aperture.	$129
625A-4	Laser Holder	$149
481A	Rotary Stage	$189
M36	Translation Stage	$249
460A-XY	X-Y Translation Stage	$189
M37	3 Axis Trans. Stage	$289
415	Vertical Trans. Stage	$129
M360-90	Mnting. Plate 90deg.	$ 29
M436	Translation Stage	$199
M150	Magnetic Mtg. Base	$129
420	Linear Trans. Stage	$119
HP10703A	INTERFEROMETER	$129
HP10702A	INTERFEROMETER	$129
HP10780A	RECEIVER	$199
RUCKER & KOLLS 222	X-Y-Z Micro Positioner	$ 50

10V @ 2.5 AH SEALED, LEAD ACID, PACK.

Each pack has 5 2 Volt cells. "D" size cells are arranged as 1X5 cells. Enclosed in an ABS outer shell. Removed for photo. Perfect for high drain applications. Make custom packs of any rating. Size: 7.5"L x 2.8"H x 1.5"D. **SALE! 6-five packs for $20, 40 for $99**

OPTICAL EXPERIMENTERS DELIGHT, Light Source, Fibre Optics, Two Detectors, Four Bandpass Filters, Stepper Motor, A/D Converter..... What more do you want?

We are sure this would make an interesting building block for the circuit savvy among you. A precision mini lamp sends to illuminate a bifurcated F.O. cable. One leg, 2 detector, presumably to compensate for any change in the source intensity. The other leg, 12"L terminates at a mini convex projection lens and illuminates an unknown item under scrutiny. Light passing through the subject matter is gathered by another mini lens and directed to a 2" diameter filter wheel with 4 1/2" diam. bandpass filters with pass wavelengths of: 409nm, 450nm, 490nm and 630nm, individually selected with the help of a mini stepper motor and gears. Light passing through the filters is detected via a large area photo diode whose output is presumably passed to the a/d converter (ADI 7533KR) and the rest of the surface mount components. Very nicely made, shielded and supported on an intricate aluminum extrusion. (black anodized.) Overall size of the assembly is 5.6"L x 2"W x 8.5"H. Now you know what we know. Must have cost a bundle. Our price, less than the cost of one bandpass filter.

SUPER EXPERIMENTERS SPECIAL.....$39ea.

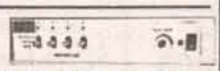
FUTABA, 2X20 VACUUM FLUORESCENT DISPLAY MODULE

New or like new, model M202SD series. Can directly replace LCD displays. The module includes the VFD, microcomputer and driver. Connects directly to the system bus. Display up to 40 dot matrix, 5 x 7 characters (222 characters and symbols), 5mm H x 3.5mm W with cursor. Display color is green at 505nm. Brightness is 690 cd/m² with four level dimming function. Weight: 5 oz. Size: 6.7"L x 2.6"H x 1" thick. Power required is 5VDC @ 350mA. Serial or parallel interface selectable. Perfect for any high visibility display requirement. With data. ***SPECIAL FUTABA.....$15ea. 3 for $39***

DAYLIGHT/LOW LIGHT MINI CAM & A/I LENS,

For dawn 'till dusk applications. Rugged alum. housing, dual mtg. sockets. 1/3" CCD, 420 lines res., 0.1 Lux sens., AGC, 12VDC @120mA. Take full advantage of camera sensitivity with super, 4mm, f1.4, 78° FOV Auto Iris lens included. BNC video out. 50mm sq. X 65mmL. With pwr. adapt. **SPECIAL, GM-510A/I...$189 or 2/$349**

NEW! 4 or 8 CHANNEL, SEQUENCER



Model GM34 or GM38. Connect to any four standard video signals and they will be sequentially output to the dual rear panel BNC outputs. Front panel user adjustable, variable dwell 1 to 15 sec per channel. Auto or manual switching with channel bypass. Compact only 8.6"W x 3.7" D x 1.75" H, ac powered. Video loop through. **Special, GM-34..$69, GM-38..$89**

SUPER, MINI C-MOUNT CAMERAS, Super sensitive, GM410 or the general purpose GM412,

The GM-412 specs: B&W, size 1.5"sq. X 2.4"L, 250,000 Pixels, 380 Lines Resolution, Sensitivity 0.3 Lux. The GM410 specs: size only 1.5" SQ. x 1.6"L, >270,000 Pixels, 410 Lines Res., Sens. 0.05 LUX., Both cameras are 1/3" CCD with AGC & Electronic shutter. 12V @110mA power. NTSC out. IR SENSITIVE, BNC video out, Both use std. DC pwr. jack. Aluminum housings with dual threaded top and bottom mounting. True performance not hype! These cameras will outperform *ANY* camera in this magazine. Multi-lens options are available to exploit their superior performance. GM412 shown bottom. GM410 shown top.

GM412, less lens..$119,
GM410, less lens..$169

low cost MICRO CAMERAS, w/audio 1/3"

CCD, 410 Lines Res., 0.3 Lux sens., AGC, Auto Shutter. Pwr. from 9 to 12VDC @100mA, 250k PIXELS, Std. model, 4mm, 78° FOV lens, Pinhole, 90° FOV. A real glass lens. Both focus from 10mm to infinity. Std. NTSC video out. 1/2 ounce! SENSITIVE to IR. Size Std: 1.25"sq. x 1"d. PH is 0.6"d, 1.6M long wiring harness with connectors included. **WARNING:** Don't confuse these models with LOW RESOLUTION, HIGH LUX C-MOS CAMERAS.

GM-1000A-STD.....$59 GM-1000A-STD/Aud.....$64
GM-1000A-PH.....$59 GM-1000A-PH/Aud.....$64
GM-1000A-CMNT..$59 GM-1000A-CMNT/Aud.$64

Micro Lenses for GM1000 series

2.5mm, 150°.....$22	8.0mm, f2.0.....$22
4.3mm, 78° f1.8.....$22	12.0mm, f2.0.....$22
6.0mm, f2.0.....$22	5mm, 70°PH.....$22

C-MOUNT LENSES

LOW LIGHT	STANDARD
16mm, f1.6, 15° FOV $39	4mm, 80° FOV $24
8mm, f1.3, 40° FOV $49	8mm, 40° FOV $24
4mm, f1.4, 78° FOV $49	12mm, 28° FOV $24

Please fax us your list of unique surplus material.

MOTORIZED ZOOM LENS SPECIAL 6X magnification, 12X on a 1/3" camera! Auto iris too!

New, fabulous hi-res. optics with std. C-Mount. Superior Fujinon and Vicon lenses. Normally cost from $600 to $1500. There is no substitute for a good lens! All drive motors will operate from 6-12VDC. Auto iris has a built in amp which works with any cameras video output for control.

Type B-6, 12.5 to 75mm, 6X, f1.2 ..... $179 or 2 for $349
ZOOM LENS CONTROLLER, NEW $169

MINI ROTARY DRIVE with on board LINEAR SLIDE,

Provides 300° rotation between removeable stop. Rotates continuously with-out stop. 2 optical position sensors for start & end. Same stepper as above. Each full step = ~0.25° of rotation. Made from cast & machined resin & alum. Attached slide provides 3" travel. Construction similar to slide above. Moves 0.008" per step. Dual optrical end of travel sensors. Overall: 7.5"L x 5.25"W x 4.5"H. **MRD-1....$39 or 2/$69**

NEW, TRIPLE OUTPUT, 60W, POWER SUPPLY

Astec model: SA40-1313, outputs of +12VDC @ 3Amps, +5V @ 5Amps and -12V @ 350mA. 110VAC input. Very compact size: 3"W x 5"L x 1.3"H Perfect for many hobby applications as well as an external disk drive power supply.

SPECIAL.....$5ea. or 5 for $20

DEL TRON LINEAR SLIDE with CLEVER LEVER

An interesting assembly, consisting of a Del Tron mini linear, ball bearing slide (2.5"L x 1"W x 0.56"H) with 2" travel. Slide is placed next to a 2" diam. stepper mounted wheel. A 1.5" sq., Four wire stepper, rated at 4V, 0.95A, 1.8°/step. The bottom side of the wheel acts as a cam with roller and moves a spring loaded arm (3.4"L x 1"W) up and down 1/2". All components, including an optical end of travel detector are mounted on precision machined, 0.2" thick, black anodized aluminum. Overall size: 8.5"L x 3."D x 2.5"H. Ex. Cond. Ltd. Qty. **DelTron-W.....$39ea.**

COMPACT, THK, LINEAR SLIDE with STEPPER DRIVE,

A really slick, super precision, THK LWL-12 series, recirculating ball slide with a 3.6" long toothed rack (14TPI) mounted next to the rail. The rack mates with a 0.6"diam. nylon drive gear mounted to a compact, (1.5" sq.), Four wire stepper, rated at 4V, 0.95A, 1.8°/step. One full step moves the slide approx. 0.050". All components, including an optical end of travel detector are mounted on precision machined, 0.2" thick, black anodized aluminum. Overall size: 5.5"W x 3.3"D x 3.4"H. The system provides 3.1" of extremely rigid travel. Ex. cond. Ltd. Qty. **LS-LWL-12....49ea.**

GENERAL SCANNING, TYPE M3, CLOSED LOOP, GALVANOMETER, LASER SCANNER.

Innovative motor design coupled with an advanced capacitive position detector, provides high speed, wide angle and improved stability. Using moving magnet technology this scanner provides low inertial, rigidity and low inductance. Specs include: +/-30° excursion, wobble: 1.5urad, Repeatability: 2urad, Coil Res.: 4.8 Ohms, Peak current: 10Amps, Angular sensor sens.: 8.1uA/o. A high quality galvo for demanding laser displays. Galvo only you provide the drivers. Very limited quantity.

M3 GALVO....$369ea. or $699 for a pair.

VACUUM PUMP, GAST, MAA-V111-HB, OIL-LESS DIAPHRAGM.

Self contained, rugged & long life. These 2-stage pumps operate on 115VAC @ 1.7Amps. The pump provides 28 IN HG of maximum vacuum of 0.47CFM open flow. Pump weighs 9 pounds. Perfect for commercial and industrial applications, such as agitators, graphic arts, business machines and laboratory use. Permanently lubricated and maintenance free. Like new, removed from equipment. Very limited quantity. **Reg. -$200, Our price, GAST, V111....$89ea. or 169 for a pair.**

UNIQUE, PERISTALTIC PUMP from COLE PALMER, Model 7016-20

Heavy duty, [illegible] Supplied with flex shaft coupler for 1/4" drive shaft. You supply the motor. These pumps are self priming, valveless and non clogging. [illegible]

PERIS PUMP.........$29ea. or 2 for $49

NOW YOU CAN SEE WHAT THE "FISHES ARE DOIN" (down 50 ft.) UNDERWATER B&W CAMERA with INTERNAL, INFRA-RED ILLUMINATOR!

[illegible] WATERPROOF. [illegible] 1/3" CCD, 400 Lines res., 0.05 lux sensitivity, AGC, Auto Shutter, 12VDC @225mA, 4mm, 78° FOV lens, A real glass lens. NTSC video out. Superior construction. SENSITIVE to IR. Ultra small Size only 1.25"diam. x 3" long. With 60 ft. cable. Perfect as a remote drive [illegible] camera. Great for general purpose [illegible]. **GM-300KIR......$199**

TEKTRONIX 2465-DM, 4 Chan., 300MHz, O'Scope, on screen waveform stats & DMM READOUT

One of the most popular & powerful scopes available at a reasonable cost.

Features: 500ps/Div sweep, 2mV/Div vertical sensitivity, 1Mohm / 50-ohm input, 500MHz trigger bandwidth, four channels. On-screen waveform cursors provide vert. & horiz. scale factors, trigger level, voltage, time, freq., phase, ratio values and mode indication. Plus complete DMM! Complete with 2 probes and manual. Excellent condition. 90 day warranty. **$2295.**

MICRO CAMERA, with MIRROR IMAGE

Perfect for "rear view". 1/3" CCD, with 268K Pixels, 410 Lines Res., 0.3 lux sens., AGC and Auto/Man Shutter. Low Power 12VDC @100mA, 3.6mm, 92° FOV, focus from 30mm to infinity. A real glass lens! WHY BUY [illegible] New first quality. Standard NTSC video out. [illegible]

GM251, with AC power adapter....$69ea.

MOTORIZED LINEAR SLIDE, offers 0.001" per step travel.

A THK, LWL 12 series re-circulating, ball bearing slide with a 4.7" long steel rail is mounted to a 0.2" thick, black anodized, aluminum plate. The slide has a right angle bracket attached to a spring loaded, anti backlash, drive nut, riding on a 0.37" diam. 100TPI lead screw which is coupled to one end of a dual 1/4" shaft, stepper motor with specs: 1.8°/step, 5V @ 1Amp, 4 wire. [illegible] **LWL12-2.5adapter.....$59ea.**

MOTORIZED LINEAR SLIDE, Provides precise fluid metering up to 1.0ml in 0.01ml steps! As well as 2.5" of 0.001" per step travel.

A precision dual [illegible] syringe assembly with a 10ml capacity is mounted to the top side of [illegible] THK, LWL 12 series re-circulating, ball bearing slide with a 4.7" long steel rail is mounted to a 0.2" thick, black anodized, aluminum plate. The slide has a right angle bracket attached to a spring loaded, anti backlash, drive nut, riding on a 0.37" diam. 100TPI lead screw which is coupled to one end of a dual 1/4" shaft, stepper motor with specs: 1.8°/step, 5V@1Amp, 4 wire. Optical end of travel sensor is also in place. Excellent condition. Ltd. Qty. **LWLT2-SYR.......$69ea. 2/$129**

EXTREMELY HIGH VOLTAGE POWER SUPPLIES UP TO 180KV !

- GLASSMAN, 0 to 180KVDC @ 5mA, with high voltage stack. HV driver is rack size, like new condition. **GLASSMAN, 180KV Supply w Stack,...$1495ea.**
- ELECTRONIC MEASUREMENTS INC / ALE-4060, 0 to 60KVDC @ 100mA, Brand new in original boxes. High voltage driver and voltage multiplier in two separate units, p-p ripple 40 V full load. External programming voltage 0-10VDC. Output V & I monitors, 0-10VDC. **EMC/ALE-4060, 0-60KV Supply,............$1850ea.**
- Kaiser Systems, model 51-40-12, A state-of the art, rack mount with digital readout. Provides 0 to -40KVDC @ up to 12.5mA. Like new. **KAISER SYSTEMS, -40KVDC Supply.......$895ea.**
- TREK-678, 0 to -30KVDC, high voltage, high speed "amplifier" provides high voltage output which follows a 0-10VDC control voltage with fast response and settling time. Rack size, like new. **TREK- 678, -30KV Supply/Amplifier.......$995ea.**
- TREK-676, 0-20KVDC, high voltage, high speed "amplifier" provides high voltage output which follows a 0-10VDC control voltage with fast response and settling time. Rack size, like new. **TREK- 676, -20KV Supply/Amplifier......$895ea.**
- GLASSMAN, 0 to -20KVDC @ 20mA, rack size. Model [illegible]. Excellent condition. **GLASSMAN, -20KV Supply.......................$795ea.**
- DELL ELECTRONICS, model 2.5-10-1A, 0 to 2.5KVDC @ 10mA, provides negative output as supplied but can be modified for positive output. Excellent condition. **DELL-2.5-10-1A, -2.5KV supply..............$59ea.**

HIGH VOLTAGE MULTIPLIER STACKS, 200,000 VOLTS, PLUS! From Farnum, Wallis or Glassman Excellent condition.........$495ea.

SMOOTH AS SILK, Dual Axis MOTORIZED LINEAR SLIDES, Provide a 9" x 4.3" work envelope.

[illegible] bearing slides, one with a 4.3" long rail and the other with an 11.5" rail are mounted to each other via a 0.2" thick black anodized, aluminum 90° bracket. Slide motion is provided via a [illegible] is restrained and powered by independent stepper motors. [illegible] Each full step of either motor provides [illegible] of travel. One optical end-of-travel sensor is attached to the short axis. Can be easily separated for use as two separate drives. Excellent condition. Very limited quantity. **Special, DUAL-LWL1......$99ea.**

NEW, "STEALTH CAM", MICRO SIZE, with AUDIO!

The sleek aluminum housing fits like a glove! Removable mtg. bracket & a 1.3M cable with BNC vid., RCA aud., (internal mic) & DC pwr. jack for no sweat hook up. Why fool around with an open P.C. board? Now you can have the "STEALTH CAM"•1/3" CCD •410 Lines•0.3 Lux• AGC•Auto Shutter•Pwr. 12V @110mA•250K pixels•Std. 4mm, 78° FOV lens•Pinhole 90° FOV•Focus 10mm to inf.•NTSC video•coaxial•IR SENSITIVE•Size Std. 30mm sq. x 29mm d. PH. 16mm d. Don't confuse with LOW RES., HIGH LUX C-MOS CAMERAS.

GM-2000S-STD OR PH, w/aud., ...$79.00

UNUSUAL, DUAL ROTARY MOTION TABLE offers 2 independent drives with 0.02° per step!

A heavy duty, 23"L X 15.25"W x 5/8" thick, black anodized alum. panel serves as the base for two concentrically aligned, rotary motion units. The outer, "platter" is 13" d x 0.1" thick blk. anodized alum. Drive is via a toothed belt & direct coupled 3.2" toothed pulley, driven by a stepper mounted 1/2"diam. pulley. Stepper is: 2.2" d, size 23, 1.8° /step, 5V@1Amp, 4 wire. The inner "platter" sits 2.7" above the 13" platter. Its' outer diameter is 4". An additional raised center section of 2" diam. elevated 1" above the 4" diam. can act as a "hub". The inner platter drive is via a toothed belt & direct coupled 3" toothed pulley, driven by a stepper mounted 1/2"diam. pulley. Stepper is: 1.5" sq., 1.8° /step, 4V@1Amp, 4 wire. Steppers are fully independent allowing. The large base provides the perfect area to "breadboard" your mechanical marvel. Excellent condition.

DUAL PLATTER ....$69ea. or 2 / $119

NEW, 2.4GHz VIDEO+STEREO AUDIO TRANSMITTER with SONY, CCM-PC5 COLOR CAMERA.

Originally sold for $500! now available for a fraction of that price. Great looking styling. Camera has a very stable, adjustable tilting base, front panel LED pwr. indicator and sensitive built in electret mic. providing excellent audio and video performance from one compact package. Simply connect camera to the completely self contained 2.4GHz transmitter. All

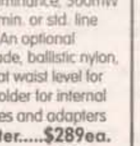
cables supplied. You can transmit up to 700 feet clear line of sight! Companion matching receiver works with any TV or VCR. Internal patch antennas. Camera has adjustable focus 6mm lens. 11" to infinity, macro capable! Auto power off when the privacy shutter is closed. Power is 7-13VDC (all pwr. adapters and cables included) 1/3" CCD, 330Lines res. 35% better than standard VHS! Can als be used to transmit VCR aputput to another TV for remote viewing.

SONY-ASTROVIEW COMBO..$189ea. or 2/$339
2.4GHz TRANSMITTER & RECEIVER..........$129 pair.
SONY COLOR CAMERA with AUDIO........$69ea.

NEW! LCD COLOR, TFT, ACTIVE MATRIX DISPLAY offers 5.6" VIEWABLE AREA.

You asked for it. Finally we found a unit with exceptional quality at an affordable price. Perfect as a portable, general purpose color monitor for standard NTSC color or B&W video systems. Fully compatible with all our cameras as well as Camcorder, VCR's etc. Perfect as a rear view system with any video camera by virtue of its built in, mirror image function. Completely enclosed unit has adjustments for color, contrast and brightness and a volume control for it's internal stereo speakers! Also has a std. 1/4 x 20 Tripod socket and a tilt down stand for table top viewing. Inputs include: audio (L&R) and video on std. 1/8" mini jacks. External 12VDC on std. barrel connector. Specifications: 5.6", TFT active matrix LCD with 76.8K Pixels, CCFL backlight with 270cd/m Luminance, 500mW audio output available on std. 1/8" jack. 12V@600mA powered, 50mV min. or std. line level audio input. Overall size: 6.4"W x 5.25"H x 2.2D" New first quality. An optional accessory kit is available which includes: A luggage quality, custom made, ballistic nylon, padded case with dual removable straps for shoulder and/or holding at waist level for portable, hands free viewing. Built into bottom of case is "AA" battery holder for internal power pack. (less batteries) Also supplied is a complete set of A/V cables and adapters with remote power switch. **GM-TFT56, with AC power adapter.....$289ea.**
GM-ACCYTFT..$25

MINI- BAR CODE SCANNER from SYMBOL TECHNOLOGIES,

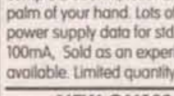


Like new, removed from equipment. Symbol model: LS-6820 series. A complete 650nm, laser diode based, high speed scanner that fits in the palm of your hand. Lots of goodies inside. Supplied with pinout and power supply data for std. connector. Operates on approx. 6VDC @ 100mA. Sold as an experimenters item only. No addt'l. tech. support available. Limited quantity. **LS-6820,...$39ea. 2 / $69**

NEW GM182, 580 LINE, CCD CAMERA,

1/3" CCD, 580 Lines Res., 0.1 Lux sens., AGC, Auto Shutter. Pwr. 12VDC @120mA, 3.6mm, 71° FOV, Real glass lens. Focus from 10mm to infinity. Standard NTSC video out. 1/2 once! SENSITIVE to IR. Size: 1.7"sq. x 1"d. with 6" leads. 12VDC Power adapter included. Superior performance. **GM182, SPECIAL $159ea.**

END FIELD of VIEW GUESSWORK! 3.5 to 8mm VARI-FOCAL LENS



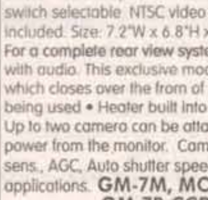
Brand New, super f1.8 lens allows you to smoothly adjust from a 97 °FOV @ 3.5mm to a 44° FOV @ 8mm. Now you can frame your area of interest just the way you want it! Standard CS-Mount with adjustable focus and iris.
SPECIAL.....$89ea. or 2 for $169

NEW! GM-7M, HI RES., 600 LINE, 7" MINI MONITOR perfect for rear view system or other DC power applications.

NEW! GM-7M, B&W video monitor. Can be operated from 11V to 32VDC. @ 1.5Amps. These deluxe units feature: • Automatic rear sense line. Turns system on when vehicle put into reverse • Automatic dimmer for night operation • adjustable brightness • A/V out for recording • glare reducing sun shield • built in speaker • reverse image selectable • Accepts up to two switch selectable NTSC video signals • Adjustable mounting bracket included. Size: 7.2"W x 6.8"H x 8.7" D.

For a complete rear view system: order our GM-7B weatherproof camera with audio. This exclusive model features • an automatic protection shutter which closes over the from of the camera to protect it from abuse when not being used • Heater built into camera housing for all weather operation • Up to two camera can be attached to one monitor • Cameras receive their power from the monitor. Camera specs: CCD, 380 Lines Res., 0.3 Lux sens., AGC, Auto shutter speed, 130° FOV. Superior quality for demanding applications. **GM-7M, MONITOR................$199ea.**
GM-7B CCD CAMERA and GM-7M......$369set

$5000 HI-TECH SURVEILLANCE SYSTEM, NOW 83% OFF!



THIS SUPER SYSTEM INCLUDES:

- *MOTORIZED, 6X ZOOM LENS*
- *MOTORIZED, 360 ° PAN*
- *MOTORIZED, TILT up to 90°*
- *PHILIPS HIGH RES. 1/2" CCD CAM.*
- *OPAQUE BLACK INNER DOME*
- *CLEAR ACRYLIC OUTER DOME*
- *ZOOM LENS CONTROLLER with A/I*
- *PAN and TILT CONTROLLER*

Walk into any major department store and you will see these fully integrated systems. Manufactured by Sensormatic, the same company who supplied the Atlanta Olympics! These are late model, new in the box systems. Virtually ready to use. All you add is power and cable.A quality Philips, 1/2", B&W CCD camera provides 450 lines resolution and 0.5 Lux sensitivity! Anodized aluminum construction. Camera plus Pan & Tilt are powered by external 24VAC via the included Pan & Tilt controller. Super 6X, f1.2 motorized, Zoom, Focus and Iris lens provides the capability of "close up" inspections. Zoom lens controller with auto iris control included. Size of dome: 14"diam. Includes mounting kit for drop ceiling installation. Sensormatic price $5000ea.

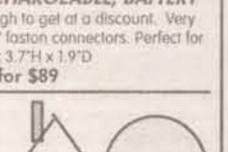
COMPLETE SYSTEM SPECIAL....$849ea. or 2 for $1599

6V@12AH SEALED, RECHARGEABLE, BATTERY

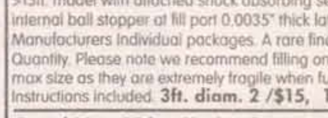
New Panasonic, LCR6V12P1. Tough to get at a discount. Very compact. Two top mounted 1/4" faston connectors. Perfect for high drain projects. Size: 5.9"L x 3.7"H x 1.9"D
2 for $20, 10 for $89

GIANT WEATHER BALLOONS,

Real military surplus, Black latex meteorological instrument balloons. 3 ft., 3/4 pound lift, or the monster >15ft."model with attached shock absorbing section and internal ball stopper at fill port 0.0035" thick latex. Manufacturers Individual packages. A rare find. Limited Quantity. Please note we recommend filling only to half max size as they are extremely fragile when fully inflated. Instructions included. **3ft. diam. 2 /$15, 15ft. diam. $24ea. 3 /$59**



Brand New, Video Motion Sensor.



Model VM10. Attach to any standard video signal and you've got an electronic "watchman" diligently watching the entire scene. Or any adjustable sized area within the scene. Such as a doorway or even a drawer or cabinet. A state of the art security aid. The unit will close a contact when it senses a change. Use it to turn on a VCR or call the hounds. Auto or manual reset. Compact, ac powered. Adjustable sensitivity. Video loop through. **NEW, VM10......$189ea.**

SEE in TOTAL DARKNESS! New, WEATHER PROOF IR FLOODs, Three models cover up to 180 feet!

Model WPIR-A: 48 powerful LED's project a 30 deg. FOV beam up to 45 feet.
Model WPIR-B: With the same external package and dimensions as the A model providing over 250% more illumination distance; up to 120 feet! The B model utilizes a Quartz Halogen lamp with a 10° beam spread and a custom made bandpass filter of approx 840nm-1200nm.
Model WPIR-C: Provides illumination up to 180 feet. The C model utilizes a Quartz Halogen lamp with a 30° beam spread and a custom made bandpass filter of approx 840nm-1200nm. Features common to all 3 models include: CDS controlled automatic on at dusk off at dawn! 110VAC power. Rugged anodized aluminum, housing with adjustable mounting bracket. Size for the Type A & B: 4"x5"x6.3"L and for the type C: 13.4"L x 7"H x 7.1"W. Weight for A or B is: 3.5lbs. Weight for C is: 10lbs. All commercially made and brand new!
WPIR-A/45ft...$169. WPIR-B/120ft...$229. WPIR-C/180ft...$359.

All floods achieve excellent performance with the GM-410 shown on the previous page. Only $149 with the purchase of an IR Flood!

Write in 139 on Reader Service Card.

Events

CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 92879
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

NOVEMBER 1999

NOVEMBER 5-6

LA - MONROE - Hamfest. Twin City Ham Club, Jim Rasch K5JMR, 318-372-8164. E-Mail: tchc@qsl.net Web: http://www.qsl.net/tchc

NOVEMBER 6

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - SORRENTO - Hamfest. East Lake Chamber of Commerce Bldg. VE Exams. Talk-in: 147.255. Lake ARA, John Wentz W8HFK, 352-728-2615. E-Mail: capias@gate.com Chuck Crittenden KE4EXM, 352-669-2075. Web: http://www.qsl.net/kf4c/index.html

IL - BELLEVILLE - Hamfest. Belleville Area College, Carlyle Rd. (Rt. 161) & Green Mount Rd., Main Campus. 8am-2pm. VE testing. Talk-in: 147.120 K9GXU repeater. Scott Composite ARS, Howard "Skip" Mize KA9VKE, 618-277-9767. E-Mail: fiuinc@peaknet.net

IN - FORT WAYNE - Hamfest & State Conv. Allen County War Memorial Coliseum Expo Center. Sat: 9am-4pm, Sun: 9am-3pm. Talk-in: 146.88-. ACARTS, 219-484-1314. Web: http://www.pipeline.com/~dagagnon/

KY - HAZARD - Hamfest. High School, Hwy. 15 S. & Bulldog Rd. 8am-2pm. VEC exams by WCARS. Talk-in: 146.07/.67. Kentucky Mountains ARC, John Farler K4AVX, 606-436-5354. E-Mail: jfarler@mis.net Web: http://www.geocities.com/SiliconValley/2564/kmarc.ht

NH - MANCHESTER - Hamfest. St. John Church. 305 Kelley St. Talk-in: 146.850 PL 85.4. Paul K1LLX 603-432-1538. E-Mail: K1LLX@juno.com

OK - ENID - Hamfest. Garfield County Fairgrounds, Hoover Bldg., Oxford & 4th. 8am-5pm. VE testing. Talk-in: 147.150+ or 444.400+. Enid Hamfest Group, Tom Worth N5LWT, 580-233-8473. E-Mail: n5lwt@hotmail.com

SC - MYRTLE BEACH - Beachfest '99. Old Myrtle Beach Air Force Base. 7am-2pm. Talk-in: 147.120 +600. Grand Strand ARC, Jim Wood KF4CJE, 843-238-0800. E-Mail: kf4cje@juno.com Web: http://www.w4gs.org

WI - MILWAUKEE - Hamfest. Milwaukee Repeater Club, Mike Borchardt N9NPB, 414-367-3953. Web: http://execpc.com/~mrc/friendlyfest.htm

NOVEMBER 6-7

GA - LAWRENCEVILLE - Hamfest. Gwinnett County Fairgrounds. Talk-in: 145.45- (PL 107.2), 444.25+ (PL131.8), 146.76- (PL 107.2). Alford Memorial RC, Hotline: 770-410-3989. E-Mail: hamfest@totrbbs.radio.org

TX - ODESSA - Hamfest. West Texas ARC, Robert Jordan N5RKN, 915-335-7980. E-Mail: n5rkn@apex2000.net Web: http://www.wt5arc.org Web: http://nonprofit.apex2000.net/hamfest/

NOVEMBER 7

MI - ST. JOSEPH - Hamfest. Blossomland ARA, Duane Durflinger KX8D, 616-982-0404. E-Mail: comdac@comdac.com Web: http://www.comdac.com/bara

NY - POUGHKEEPSIE - Hamfest. Mt. Beacon ARC, Ken Akasofu KL7JCQ, 914-485-9617. E-Mail: kl7jcq@arrl.net Web: http://www.mhv.net/~fritzing

PA - LINGLESTOWN - Hamfest. Linglestown Fire Hall. VE testing. Talk-in: 145.470 & 146.520 simplex. Central PA Repeater Assn., Harold Baer KE3TM, 717-566-8895

WI - KAUKAUNA - Hamfest. Starlight Club. VE testing. Talk-in: 146.52 simplex. Fox Cities ARC, Chad Pennings N9PRC, 920-993-0485. E-Mail: n9prc@kb9byq.ampr.org Web: http://www.w9zl.ampr.org

NOVEMBER 13

AL - MONTGOMERY - State Convention. Garrett Coliseum, South AL State Fairgrounds, Federal Dr. 9am-3pm. FCC exams. Talk-in: 146.24/84, W4AP. Montgomery ARC, Phil Salley K4OZN, 334-272-7980 after 5pm CST. E-Mail: wb4ozn@worldnet.att.net Web: http://jschool.troyst.edu/~w4ap/

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

FL - MIAMI - Hamfest. Physics Parking Lot of University of Miami. Talk-in: 146.865 (-6). Flamingo Net/U of M ARC, Walt W4DWN, 305-895-0398.

FL - PORT ST. LUCIE - Hamfest. Port St. Lucie ARA, Bill Sullivan WA2TSM, 561-343-0557. Web: http://www.qsl.net/pslara

NM - SOCORRO - Hamfest. Socorro ARA, Al Braun AC5BX, 505-835-3456. E-Mail: ac5bx@juno.com Web: http://www.ees.nmt.edu/sara/homepage.html

NOVEMBER 13-14

IN - FORT WAYNE - IN State ARRL Convention & Hamfest. Allen County War Memorial Coliseum Expo Center. Sat: 9am-4pm, Sun: 9am-3pm. Talk-in: 146.88-. Allen County AR Technical Society, Doug Jones N9NNT, 219-484-1314; E-Mail: djones2233@aol.com, Jim Boyer KB9IH, 219-484-3317. Web: http://www.acarts.com

NOVEMBER 14

IL - LITCHFIELD - Hamfest. Central IL/St. Louis Area ATV Club, Scott Millick K9SM, 217-532-3837. E-Mail: smillick@cillnet.com

IL - PEORIA - Autonomous Sumo Robot Competition. 1pm. Central IL Robotics Club, Jim Munro. E-Mail: jimmn@xnet.com Web: http://circ.mtco.com/contest.htm

NY - FARMINGDALE - Hamfest. Radio Central ARC, Neil Heft KC2KY, 516-737-0019. E-Mail: nheft@ibm.net Web: http://www.li.net/~n2mdq

NOVEMBER 19-20

MS - OCEAN SPRINGS - Hamfest. St. Martin Community Center. Fri: 5-9pm, Sat: 8am-2pm. VEC testing Sat: 11am. Talk-in: N5OS 145.11-. West Jackson County ARC, Phil Hunsberger W9NZ, 228-872-1499. Stan Hecker N5SP, 228-875-0222

NOVEMBER 20

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

CO - GOLDEN - Hamfest. Jefferson County Fairgrounds, 15200 W. 6th Ave. 8am-2pm. VE testing. Talk-in: 144.62/145.22. Rocky Mountain Radio League, Inc., Ron Rose N0MQJ, 303-985-8692. E-Mail: n0mqj@arrl.net Web: http://rmrl.hamradios.com

MA - NEWTONVILLE - Auction. Masonic Hall, second floor, 460 Newtonville Ave. 11am-4pm. WARA/1200 RC, Eliot Mayer W1MJ, 617-484-1089. E-Mail: W1MJ@amsat.org Web: http://ourworld.compuserve.com/homepages/emayer/auct

OH - GEORGETOWN - Hamfest. Grant ARC, Dorothy Silman KB8TQU, 937-446-2234. E-Mail: huggee@bright.net Web: http://www.qsl.net/~n1djs

NOVEMBER 20-21

FL - TAMPA - Suncoast Hamfest, FL State ARRL Convention. State Fairgrounds, Expo Hall. Florida Gulf Coast Amateur Radio Council, Jean Endicott KC4KZU, 727-525-5178. E-Mail: swaps@fgcarc.org Web: http://www.fgcarc.org

NOVEMBER 21

NC - BENSON - Hamfest. Johnston ARS, Doug Williams KS4TI, E-Mail: ks4ti@nceye.net Web: http://www.jars.net

NOVEMBER 26

NJ - FAIR LAWN - Auction. Fair Lawn ARC, John Garis N2VKY, 201-444-0885. E-Mail: jgaris@worldnet.att.net

NOVEMBER 27

IN - EVANSVILLE - Hamfest. Vanderburgh Co. 4-H Center, Fairgrounds Auditorium. 8am-2pm. EARS, Neil Rapp WB9VPG, 812-479-5741. E-Mail: earsham@aol.com Web: http://members.aol.com/earsham

NC - GREENSBORO - Hamfest. Greensboro Coliseum Special Events Center. GGH, 336-851-1676. Web: http://www.sabwc.com/gsohamfest

NOVEMBER 28

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

IL - WHEATON - Hamfest. DuPage County Fairgrounds. GMRS of IL, Inc., 815-436-7090 or 630-393-3937

NY - PATCHOGUE - Hamfest. Mid-Island ARC, Mike Grant N2OX, 516-736-9126. E-Mail: globalcm@erols.com Web: http://www.qsl.net/mid-islandarc/hamfest.html

COMPUTER SHOWS

AGI Shows, 317-299-8827.
E-Mail: info@agishows.com
http://www.agishows.com

Blue Star Productions
612-788-1901.
http://www.supercomputersale.com

Computers And You, 734-283-1754.
www.a1-supercomputersales.com

Computer Central Shows
847-412-1900 & 1-888-296-6066.
E-Mail: compcent@megsinet.net
www.computercentralshows.com

Five Star Productions
810-379-3333. E-Mail: jeff@fivestar
www.fivestarshows.com

Georgia Mountain Productions
706-838-4827.
E-Mail: gamtnpro@blrg.tds.net
georgiamountain.com

Gibraltar Trade Center, Inc.
734-287-2000. Taylor, MI.
E-Mail: taylor@gibraltartrade.com
www.gibraltartrade.com

Gibraltar Trade Center, Inc.
810-465-6440. Mt. Clemens, MI.
E-Mail: mtclemens@gibraltartrade.com
www.gibraltartrade.com

KGP Productions
1-800-631-0062, 732-297-2526.
E-Mail: kgp@mail.com

MarketPro, Inc., 201-825-2229.
http://www.marketpro.com

MarketPro, Inc., 301-984-0880.
E-Mail: md@marketpro.com
http://marketpro.com

Narisaam Computer Show
770-663-0983.
E-Mail: narisaam@aol.com
Web: http://www.shownsale.com

Northern Computer Shows
978-744-8440.
E-Mail: inquiries@ncshows.com
Web: ncshows.com

Peter Trapp Computer Shows
603-272-5008.
Web: www.petertrapp.com

DECEMBER 1999

DECEMBER 4

AZ - MESA - Hamfest. AR Council of AZ, Mark Kesauer N7KKQ, 602-779-2722. E-Mail: arcathill@aol.com

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - OKEECHOBEE - Hamfest. Okeechobee ARC, Bill Gastle, E-Mail: wgastle@okeechobee.com

GA - CLAXTON - Hamfest. Claxton ARES, John Perkins W4HYU, 912-739-4589. E-Mail: w4hyu@juno.com

LA - MINDEN - Hamfest. Minden ARA, Lowell A. "Dusty" Collins KB5WFE, 318-371-0636. E-Mail: dusty1@microgear.net Web: http://www.microgear.net/gwinford/mara.htm

DECEMBER 5

IN - GREENFIELD - Hamfest. Greenfield Central High School Pavilion, N. Broadway St. Talk-in: 145.330, 444.725. Hancock ARC, Tom Donaldson N9LFU, 317-326-3168. E-Mail: tomd@freewwweb.com Web: http://www.iei.net/~n9hqo

DECEMBER 11

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

DECEMBER 18

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-005

JANUARY 2000

JANUARY 7-8

FL - GAINESVILLE - Hamfest. Alachua County Fairgrounds, SR-222 (3400 NE 39th Ave.), 1/2 mi. E. of SR-24 (Waldo Rd.). Talk-in: 146.820 (-). Gainesville ARS, Tom Scott KF4I, 352-378-9711 eves. E-Mail: k4gnv@arrl.net Web: http://www.gars/net/hamfest/

JANUARY 8

IN - SOUTH BEND - Hamfest. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, 219-291-0252

WI - WAUKESHA - Hamfest. Waukesha Co. Expo Center Forum. 8am-2pm. VE exams. West Allis RAC, Phil Gural W9NAW, 414-425-3649.

JANUARY 8-9

FL - FT. MYERS - Hamfest. Ft. Myers ARC, Doug Douglas N8SAQ, 941-542-4741. E-Mail: douglas2@iline.com

JANUARY 15

LA - HAMMOND - Hamfest. South East LA ARC, Nathan Gifford N5BFC, 504-465-7522. E-Mail: n5bfc@arrl.net Web: http://www.selarc.org/selarchamfest.html

MO - ST. JOSEPH - Hamfest. MO Valley & Ray-Clay ARCs, Kevin R. Phillips KC0AWM, 816-320-2129. E-Mail: KevinRPhillips@hotmail.com Web: http://www.kc.net/~oconnor

JANUARY 15-16

FL - SARASOTA - Hamfest. Sarasota ARA, William Eddie Martin KI4ZJ, 941-954-1869. E-Mail: ki4zj@msn.com Web: http://www.saraclub.org

JANUARY 16

MI - HAZEL PARK - Hamfest. High School,

Events CALENDAR

23400 Hughes St. 8am-2pm. Talk-in: 146.64 (-). HPARC, Tom Krausnick WC9F, E-Mail: wc9f@arrl.org Web: http://www.qsl.net/w8hp

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

JANUARY 22

FL - BROOKSVILLE - Hamfest. Hernando County Fairgrounds. 9am-4pm. Hernando County ARA, John Nedjedlo WB4NOD, 727-856-2568. E-Mail: wb4nod@gate.net

FL - PENSACOLA - Hamfest. University of West FL ARC, Ray Killough KE4UNR, 850-968-1048. E-Mail: ke4unr@spydee.net Web: http://qso.arc.uwf.org/~hamfest

MO - ST. CHARLES - Hamfest. St. Louis Repeater, Brad Ziegler KC0CDG, 314-569-5775. E- Mail: kc0cdg@qsl.net

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

JANUARY 29

AL - GREENVILLE - Hamfest. Butler County Fairgrounds. 8am-3pm. Talk-in: 146.67 or 145.19. Butler County & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644. E-Mail: KE4ERO@alaweb.com

JANUARY 30

MD - ODENTON - Hamfest. MD Mobileers ARC, William Hampton N3WGM, 410-766-2199. E-Mail: diamondb@space4less.com Web: www.space4less.com/usr/mmarc

OH - DOVER - Hamfest. Tusco ARC, Billy Harper KB8CQG, 330-484-4634. E-Mail: bharper@neo.rr.com

FEBRUARY 2000

FEBRUARY 5

MI - NEGAUNEE - Hamfest. Hiawatha ARA, Bill Beitel N8NRG, 906-226-2779. E-Mail: n8nrg@portup.com

SC - NORTH CHARLESTON - Hamfest. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: brycemyers@aol.com Web: http://www.qsl.net/wa4usn/index.html

FEBRUARY 5-6

FL - MIAMI - Southeastern Division Convention. Dade Radio Club, Evelyn Gauzens W4WYR, 305-642-4139. E-Mail: w4wyr@bellsouth.net Web: http://www.hamboree.org

FEBRUARY 11-12-13

FL - ORLANDO - State Convention. Orlando ARC, Ken Christenson KD4JQR, 407-291-2465. E-Mail: KD4JQR@Juno.Com Web: http://www.oarc.org/hamcat.html

FEBRUARY 19

AR - RUSSELLVILLE - Hamfest. AR River Valley AR Foundation, Jonathan Setcer KC5BRY, 501-968-2938. E-Mail: hamfest@setcer.com

FEBRUARY 26

VT - MILTON - NVT Winter Hamfest. High School, Rt. 7. Mitch Stern W1SJ, 802-879-6589. E-Mail: w1sj@arrl.net Web: http://www.ranv.together.com

FEBRUARY 27

FL - ZEPHYRHILLS - Hamfest. Zephyrhills ARC, Ernie Vanselow KD4VRV, 813-783-8389 E-Mail: kd4vrv@gte.net

VA - ANNANDALE - Hamfest. Vienna Wireless Society, Mike Toia K3MT, 703-757-7021. E-Mail: k3mt@erols.com Web: http://www.erols.com/k3mt/vws

MARCH 2000

MARCH 4-5

FL - NEW PORT RICHEY - Hamfest. Gulf Coast ARC, Rickie Brown KF4GXS, 727-863-1457. E-Mail: richar@gte.net. Don KK4VK, 727-848-8000. Web: http://homel.gte.net/koerner/gcarc.htm

MARCH 5

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Lenore N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org

MARCH 11

WA - PUYALLUP - Hamfest. Mike & Key ARC, Michael Dinkelman N7WA, 253-631-3756 or 425-867-4797. E-Mail: mwdink@eskimo.com

MARCH 11-12

NC - CHARLOTTE - Charlotte Hamfest and Computerfair. Mecklenburg Amateur Radio Society.

MARCH 12

PA - YORK - Hamfest. Keystone VHF Club, Dick Goodman WA3USG, 717-697-2353. E-Mail: wa3usg@compuserve.com Web: http://members.aol.com/yorkfest

WI - WAUKESHA - Hamfest. County Expo Center, N.1 W.24848 N. View Rd. 8am-2pm. Talk-in: 146.820 PL 127.3. SEWFARS ARC, John Breecher, 414-835-7035

MARCH 17-18

GA - MARIETTA - Hamfest. Kennehoochee ARC, Charles Golsen N4TZM, 404-252-3303. E-Mail: cgolsen@atlanta.com

MARCH 18

FL - STUART - Hamfest. Martin County ARA, Romund Madson KS4KM, 561-337-1841

NJ - NORTH HUNTERDON - Hamfest. Cherryville Repeater Assn., Marty Grozinski W2CG, 908-788-2644 or 908-730-2771. E-Mail: w2cg@arrl.net

WV - CHARLESTON - Hamfest. Jimmie Hewlett WD8MKS, 304-768-1142

MARCH 18-19

TX - MIDLAND - West Texas ARRL Section Convention, Beverley Harwood KC5BNT, 915-686-1841. E-Mail: shamrock@apex2000.net Web: http://www.lxnet/edge/midswap.htm

MARCH 19

OH - MAUMEE - Hamfest. Lucas County Recreation Center, 2901 Key St. 8am-2pm. Talk-in: 147.27+ or 442.85+. Toledo Mobile RA, Paul Hanslik, 419-385-5056. Web: www.tmrahamradio.org

MARCH 25-26

MD - TIMONIUM - Greater Baltimore Hamboree & Computerfest/MD State ARRL Convention. Timonium Fairgrounds, York Rd. Sat: 8am-5pm, Sun: 8am-4pm. VE Exams. Baltimore ARC, Sharon Dobson N3QQC, 410-HAM-FEST or 800-HAM-FEST. E-Mail: n3qqc@amsat.org Web: http://www.gbhc.org

APRIL 2000

Events CALENDAR

APRIL 2

CT - SOUTHINGTON - Hamfest. Southington ARC, Chet Bacon KA1ILH, 860-628-9346. E-Mail: chet@chetbacon.com Web: http://www.chetbacon.com/sara.html

NC - KINSTON - Hamfest. Down East Hamfest Assn., Doug Burt W4OFO, 252-524-5724

APRIL 8

WA - SPOKANE - Hamfest. Lilac City ARC, Warren Kelsey KJ7BB, 509-534-8443

APRIL 9

NC - RALEIGH - State Convention. Raleigh ARC, Chuck Littlewood K4HF, 919-872-6555. E-Mail: k4hf@arrl.net Web: http://www.rars.org

WI - STOUGHTON - Hamfest. Madison Area Repeater Assn., Paul Toussaint N9VWH, 608-245-8890. E-Mail: n9vwh@arrl.net

APRIL 15

AL - ALBERTVILLE - Hamfest. Marshall County ARC, Buddy Smith KC4URL, 256-593-2516. E-Mail: kc4url@airnet.net

APRIL 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MI - GROSSE POINTE - Hamfest. South Eastern MI ARA, Jerry Rosner N8FGK, 313-331-3336. E-Mail: n8fgk@amsat.org

APRIL 21-22

AR - LITTLE ROCK - Little Rock Hamfest, Jim Blackmon K5VZ, 870-246-7833 (h) or 870-246-6734 (w). Fax: 870-246-6736. E-Mail: lrhamfest@usa.net Web: http://www.aristotle.net/~ares/hamfest/

APRIL 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

APRIL 29

AL - MOULTON - Hamfest. Bankhead ARC, Web: http://www.n4idx.org

IA - DES MOINES - Hamfest. Des Moines RAA, Duane Bower WB0UCY, 515-287-6542. E-Mail: duaneab@uswest.net

MAY 2000

MAY 6

WI - CEDARBURG - Hamfest. Ozaukee RC, Joe Holly AA9HR, 262-377-2137; E-Mail: aa9hr@execpc.com. Skip Douglas, 262-284-3271

MAY 6-7

AL - BIRMINGHAM - Hamfest. Glenn Glass KE4YZK, 205-681-5019. E-Mail: ke4yzk@bellsouth.net Web: http://www.bro.net/barc/slideshow/index.html

MAY 7

MD - HAGERSTOWN - Hamfest. Antietam Radio Assn., Tina Jones KB8ZQM, 304-728-7769. E-Mail: kb8zqm@intrepid.net Web: http://www.qsl.net/w3cwc

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

MAY 12-13

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

MAY 19-20-21

OH - DAYTON - ARRL National Convention. Dayton ARA, Dave Coons, WT8W, 937-849-0604. E-Mail: wt8w@arrl.org Web: http://www.hamvention.org

MAY 21

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

MAY 27-28

WY - CASPER - State Convention. Casper ARC, Warren (Rev) Morton WS7W, 307-235-2799 or 307-237-9301. E-Mail: mortonwg@aol.com Web: http://w3.trib.com/~carc/hamfest.html

JUNE 2000

JUNE 2-3-4

NY - ROCHESTER - Atlantic Division ARRL Convention. Harold Smith K2HC, 716-424-7184. E-Mail: rochfst@frontiernet.net Web: http://www.rochesterhamfest.org

JUNE 3-4

OR - SEASIDE - Northwestern Division ARRL Convention. Convention Center. VE testing. Talk-in: 146.660 (-600). Randy Stimson KZ7T, 503-297-1175

JUNE 4

VA - MANASSAS - Hamfest. Ole Virginia Hams ARC, Jack McDermott N4YIC, 703-330-7987. E-Mail: N4YIC@arrl.net or patnjack@erols.com Web: http://www.qsl.net/olevahams/

JUNE 10

NC - WINSTON-SALEM - Hamfest. Forsyth ARC, John Kippe N0KTY, 336-723-7388. Web: http://members.xoom.com/w4nc/hamfest.htm

PA - BLOOMSBURG - Eastern PA Section Convention. Columbia-Montour ARC, George Law N3KYZ, 570-784-2299. E-Mail: n3kyz@epix.net Web: http://www.bafn.org/~cmarc

JUNE 11

IL - WHEATON - Hamfest. Six Meter Club of Chicago, Joseph Gutwein WA9RIJ, 630-963-4922 or 708-442-4961. E-Mail: wa9rij@mc.net Web: http://cyberconnect.com/orion/smcc.html

JUNE 18

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

JULY 2000

JULY 7-8-9

UT - BRYCE CANYON - State Convention. UT Hamfest Committee, Kathy Rudnicki N7JSH, 801-547-9218

JULY 8

GA - GAINESVILLE - State Convention. Lanierland ARC, Ken Johnson NZ4Q, 706-335-9658. E-Mail: nz4q@aol.com

MO - KANSAS CITY - Hamfest. PHD ARA, Bob Roske WA0CLR, 816-436-0069. E-Mail: wa0clr@worldnet.att.net Web: http://members.tripod.com/~PHDARA/

JULY 9

Events CALENDAR

IL - PEOTONE - Hamfest. Kankakee Area Radio Society, Don Kerouac K9NR, 815-939-7548. E-Mail: k9nr@juno.com Web: http://www.w9az.com

JULY 16

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html
MO - WASHINGTON - Hamfest. Zero Beaters ARC, Dave Neal N0PNG, 314-532-2477 (days) or 314-458-3254 (eve). E-Mail: Dave_Neal@msc.com Web: http://zbarc.usmo.com/
PA - KIMBERTON - Hamfest. Mid-Atlantic ARC, Bill Owen W3KRB, 610-325-3995. E-Mail: gem@op.net Web: http://www.marc.org/hamfest.html

JULY 22

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

JULY 29-30

OK - OKLAHOMA CITY - State Convention. Central OK Radio Amateurs, Harold Miller KB1ZQ, 405-672-7735 or 405-650-9963. E-Mail: n1lpn@swbell.net Web: http://www.geocities.com/heartland/7332

JULY 30

OH - RANDOLPH - Hamfest. Portage ARC, Joanne Solak KJ3O, 330-274-8240. E-Mail: ljsolak@apk.net

AUGUST 2000

AUGUST 5

OH - COLUMBUS - Hamfest. Voice of Aladdin ARC, James Morton KB8KPJ, 614-846-7790. E-Mail: kb8kpj@cs.com

AUGUST 12

IL - QUINCY - Hamfest. Western Illinois ARC, Jim Funk, N9JF, 217-336-4191. E-Mail: jfunk@adams.net Web: http://www.qsl.net/w9awe

AUGUST 13

IA - AMANA - Hamfest. Cedar Valley ARC, Wayne Kolosik, KI0FE, 319-393-4224. E-Mail: ki0fe@usa.net
IN - GREENTOWN - Hamfest. Kokomo & Grant County ARCs, L.B. (Nick) Nickerson KA6NQW, 765-668-4814. E-Mail: ka6nqwnick@netusa1.net Web: http://www.netusa1.net/~ka6nqwnick/hamfest.html

AUGUST 20

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

AUGUST 26-27

MA - BOXBORO - NE Division ARRL Convention. Dave W1TQ, 978-649-3907

AUGUST 27

NY - YONKERS - Hamfest. Yonkers ARC, John Costa WB2AUL, 914-969-6548. E-Mail: wb2aul@aol.com

SEPTEMBER 2000

SEPTEMBER 17

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

SEPTEMBER 23

NY - HAMBURG - Western NY ARRL Section Convention. Harold Smith K2HC, 716-424-7184 E-Mail: info@buffalohamfest.org Web: http://www.buffalohamfest.org

SEPTEMBER 24

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053. E-Mail: wb2slq@juno.com Web: http://www.metro70cmnetwork.com

OCTOBER 2000

OCTOBER 6-7

NH - ROCHESTER - Hamfest. Fairgrounds. Hoss Traders, Joe, 207-469-3492

OCTOBER 6-7-8

AZ - SCOTTSDALE - Southwestern Div. Convention. Scottsdale ARC, Walt Schuknecht N7IZM, 480-947-0338. E-Mail: n7izm@arrl.net

OCTOBER 15

MA - CAMBRIDGE - Flea at MIT. Albany and Main Sts. 9am-2pm. Talk-in: 146.52 & 449.725/444.725 W1XM/R PL 114.8 (2A). Nick Altenbernd KA1MQX, 617-253-3776 (9-5). Web: http://web.mit.edu/w1mx/www/swapfest.html

OCTOBER 21

NH - NASHUA - Hamfest. Res Ctr Church. NE Antique RC 617-923-2665

OCTOBER 29

NY - LINDENHURST - Hamfest. GSBARC & SCRC, Lenore Dunlop N2KYP, 516-785-0826. E-Mail: info@gsbarc.org Web: http://www.gsbarc.org

KROHN-HITE 3342R Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave $900.00
ROCKLAND 852 Dual Highpass/ Lowpass Filter, 0.1 Hz-111 kHz $900.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series $475.00
WAVETEK 716 Brickwall Filter $1,500.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/18A/19A/20A Mixer Set, 12.4-40.0 GHz, for HP 8555A/8569A $500.00
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1,400.00
HP 70620B Preamplifier, 1.0-26.5 GHz, for 70000 series $3,900.00
HP 8559A/853A-001 Spectrum An., 0.01-21 GHz, 1 kHz res.,w/rackmount frame $3,750.00
HP 8565A-100 Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min. res $3,250.00
HP 8568B Spectrum Analyzer, 100 Hz-1.5 GHz, 10 Hz min. res. $8,500.00
HP 8569B Spectrum Analyzer, 10 MHz-22 GHz, 100 Hz min.res.bw. $7,500.00
TEK TR502 Tracking Generator, 0.1-1800 MHz, for 7L13/7L14 ..... $950.00
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYZERS

HP 11650A Network Analyzer Accessory Kit, APC7 ..... $600.00
HP 35676A Reflection/Transmission Test Kit, 5 Hz-200 MHz $1,000.00
HP 85020A Directional Bridge, 10-4300 MHz, N(f) test port $650.00
HP 85027C Directional Bridge, 0.01-18 GHz, N(f) test port $1,750.00
HP 85054A Type N Calibration Kit, for HP 8510 series $1,800.00
HP 8511A Frequency Converter, 45 MHz-26.5 GHz, for HP 8510 ..... $6,500.00
HP 8756A Scalar Network Analyzer $2,500.00
HP R85026A WR28 Detector, 26.5-40 GHz, for HP 8757 series $1,200.00
WILTRON 560-98KF50 SWR Autotester, 10 MHz-40 GHz, for Wiltron 560 series $1,800.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res., GPIB $1,900.00
FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res.,GPIB $1,500.00
FLUKE 6060B/AK Synthesized Signal Gen., 0.1-1050 MHz, 10 Hz res. $1,900.00
GIGATRONICS 1018 Synthesized Signal Gen., 50 MHz-18 GHz, 1 MHz res. $4,500.00
GIGATRONICS 600/6-12 Synthesized Source, 6-12 GHz, 1 kHz res., GPIB $2,500.00
GIGATRONICS 840-18 Freq. Multiplier, 18-26 & 26-40 GHz outputs 0 dBm $2,750.00
GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm $2,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs $3,750.00
GIGATRONICS 900/2-8 Synthesized Signal/Sweep Gen., 2-8 GHz, 1 MHz res.,GPIB $2,500.00
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm $3,750.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM, pulse modulation $950.00
HP 8656B-001 Synth. Signal Gen., 0.1-990 MHz, 10 Hz res., OCXO ref. $2,500.00
HP 8657A-002 Signal Generator, 0.1-1040 MHz, 10 Hz res., HPIB $3,250.00
HP 8660C/86602B-002 Synth. Sig. Gen., 1-1300 MHz, FM / Phase mod. w/86635A $2,750.00
HP 8660C/86603A/86633B Synthesizer, 1-2600 MHz, 1 Hz res., AM / FM $3,250.00
HP 8660D/86603A/86632B Synthesizer, 1-2600 MHz, 1 Hz res., AM / FM $4,500.00
HP 8672A Synthesized Signal Generator, 2-18 GHz, +3 dBm output $5,500.00
HP 8673D-H16 Synth.Signal Generator, 50 MHz-26 GHz, AM/FM $18,500.00
HP 8673E Synthesized Signal Generator, 2-18 GHz, +8 dBm output $9,500.00
HP 8673G-004,008 Synth. CW Signal Generator, 2-26 GHz, >+8 dBm output $12,500.00
HP 8684B Signal Generator, 5.4-12.5 GHz, AM/ WBFM/ Pulse $3,500.00

SWEEP GENERATORS

HP 8341B-004 Synthesized Sweeper, 10 MHz-20 GHz, +10 dBm;rear output $14,500.00
HP 8350A/83545A-002 Sweep Oscillator, 5.9-12.4 GHz, 70 dB step attenuator $4,000.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled $400.00
HP 8620C Sweep Oscillator Frame $550.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, +13 dBm levelled, 70 dB atten. $1,250.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled $375.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86242D-004,008 RF Plug-In, 5.9-9.0 GHz, +10 dBm levelled $300.00
HP 86245A-001 RF Plug-in, 5.9-12.4 GHz, +17 dBm levelled $600.00
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $500.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled $500.00
HP 86290A-004 RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled, rear output $1,750.00
HP 86290B-004 RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled, rear output $1,850.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld. $1,250.00
WILTRON 6647M Sweep Generator, 10 MHz-20 GHz, +10 dBm levelled $4,500.00

POWER METERS

ANRITSU MP-81B/ML-83A Power Meter, 75-110 GHz (WR10), -20 to +20 dBm $2,500.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor $450.00
HP 435B/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz $900.00
HP 435B/8481B Power Meter, 0 to +43 dBm, 10 MHz-18 GHz $1,500.00
HP 435B/8482H Power Meter, -10 to +34 dBm, 100 kHz-4.2 GHz $900.00
HP 436A-022/8481A Power Meter, -30 to +20 dBm, 10 MHz-18 GHz, HPIB $1,400.00
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP 8900D/84811A Digital Peak Power Meter, 10 MHz-18 GHz, 0- +20 dBm $2,300.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series $350.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8 ..... $1,500.00
HP R486A WR28 Thermistor Mount, 26.5-40 GHz, for 432 series $350.00
HP R8486A WR28 Power Sensor, 26.5-40 GHz, for HP 435/6/7/8 ..... $1,500.00

RF MILLIVOLTMETERS

RACAL 9303 TRMS Level Meter, 10 kHz-2 GHz, -77 to +23 dBm, GPIB $875.00

AMPLIFIERS, MISCELLANEOUS

ENI 1040L Amplifier, 55 dB gain, 10-500 kHz, 400 Watts $2,750.00
HP 415E SWR Meter $200.00
HP 8406A Comb Generator, 1/ 10/ 100 MHz increments, to 5 GHz $500.00
HP 8447A Amplifier, 20 dB, 0.1-400 MHz, 5 dB NF, +6 dBm output $375.00
HP 8447E Amplifier, 22 dB, 0.1-1300 MHz, +13 dBm output $750.00
HP 8447F-H64 Dual Amp., 25 dBG 0.1-1300 MHz & 28 dBG 9 kHz-50 MHz $900.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $2,500.00
HP 8901B-1,2,3 Modulation An., 0.15-1300 MHz, rear input, OCXO, ext.LO $3,000.00
HP 8970A Noise Figure Meter $4,000.00
RF POWER LABS ML50 Amplifier, 2-30 MHz, 47 dB gain, 50 Watts, metered, 28V $350.00
ROHDE & SCHWARTZ ESH2 Test Receiver, 9 kHz-30 MHz $5,000.00

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW* $95.00
AVANTEK AMT-400X2 WR28 Active Doubler, 13-20 GHz +10 dBm in, +10 dBm out $450.00
BAYTRON 3-28-300/10 WR28 Directional Coupler, 10 dB, 26.5-40 GHz $300.00
BIRD 6735-300 1 kW Load, 25-1000 MHz, LC(f), with wattmeter $650.00
BIRD 8201 500 Watt Oil Cooled Load, DC-2.5 GHz, N(f) $350.00
BIRD 8251 1 kW Oil-Dielectric Load, DC-2.4 GHz, N(f) $500.00
CONTINENTAL MW. RAE28-K-M WR28 x K(m) Endfire Adapter $225.00
FXR/MICROLAB S3-02N Triple Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f) $125.00
FXR/MICROLAB SL-03N Stub Tuner,) 0.3-6.0 GHz, 100 Watts max., N(m/f $75.00
GR 874-LTL Constant Impedance Trombone Line, 0-44 cm, DC-2 GHz $400.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 ..... $450.00
HP 11636A 2-Way Power Divider, DC-18 GHz, N(m/f/f) $300.00
HP 11692D Dual Directional Coupler, 22 dB, 2-18 GHz $800.00
HP 33321K Programmable Step Atten., 0-70 dB, DC-26.5 GHz, 3.5mm $475.00
HP 33327L-006 Programmable Step Attenuator, 0-70 dB, DC-40 GHz, 2.9mm $1,000.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, 100-2000 MHz, APC7 test port $450.00
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $150.00
HP 8472A Crystal Detector, 10 MHz-18 GHz, negative polarity, SMA $175.00
HP 8494G-002 Programmable Step Attenuator, 0-11 dB, DC-4 GHz, SMA $350.00
HP 8495H-002 Programmable Step Attenuator, 0-70 dB, DC-18 GHz, SMA $400.00
HP 8496A-002 Step Attenuator, 0-110 dB, DC-4 GHz, SMA $375.00
HP 8497K-004 Programmable Step Attenuator, 0-90 dB, DC-26.5 GHz $750.00
HP K382A WR42 Direct Reading Attenuator, 0-50 dB, 18-26.5 GHz $2,900.00
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $300.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R382A WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz $2,250.00
HP R422A WR28 Crystal Detector, 26.5-40 GHz $400.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz $500.00
HP R752C WR28 Directional Coupler, 10 dB, 26.5-40 GHz $450.00
HP R752D WR28 Directional Coupler, 20 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $250.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $750.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $900.00
HUGHES 45714H-1000 WR15 Frequency Meter, 50-75 GHz $900.00
HUGHES 45716H-1000 WR10 Frequency Meter, 75-110 GHz $900.00
HUGHES 45721H-2000 WR28 Direct Reading Attenuator, 0-50 dB, 26.5-40 GHz $1,000.00
HUGHES 45724H-1000 WR15 Direct Reading Attenuator, 0-50 dB, 50-75 GHz $1,000.00
HUGHES 45732H-1200 WR22 Level Set Attenuator, 0-25 dB, 33-50 GHz $250.00
HUGHES 45772H-1100 WR22 Thermistor Mount, -20 to +10 dBm, 33-50 GHz $400.00
HUGHES 45773H-1100 WR19 Thermistor Mount, -20 to +10 dBm, 40-60 GHz $650.00
HUGHES 45774H-1100 WR15 Thermistor Mount, -20 to +10 dBm, 50-75 GHz $750.00
HUGHES 45775H-1100 WR12 Thermistor Mount, -20 to +10 dBm, 60-90 GHz $800.00
HUGHES 45776H-1100 WR10 Thermistor Mount, -20 to +10 dBm, 75-110 GHz $850.00
HUGHES 47316H-1111 WR10 Tuneable Detector, 75-110 GHz, positive polarity $600.00
HUGHES 47741H-2310 WR28 Phase Locked Gunn Osc., 32.000 GHz, +18 dBm $2,000.00
HUGHES 47742H-1210 WR22 Phase Locked Gunn Osc., 42.000 GHz, +18 dBm $2,750.00
HUGHES 47974H-1000 WR15 SPST PIN Switch, 250 MHz speed, 60-62 GHz response $375.00
KRYTAR 2616S Directional Detector, 1.7-26.5 GHz, K(f/m)/SMC $200.00
M/A-COM 3-19-300/10 WR19 Directional Coupler, 10 dB, 40-60 GHz $450.00
MICA C-121S06 Circulator, 17.5-24.5 GHz, SMA(f/m/m) $75.00
MIDWEST MICROWAVE 3537 DC Block, 0.1-12.4 GHz, SMA(m/f) *NEW* $40.00
MINI-CIRCUITS ZFDC-20-4 Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f) $25.00
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3022 Bi-Directional Coupler, 20 dB, 1-4 GHz $375.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368BNM Coaxial High Power Load, 500 Watts, 2.0-18 GHz, N(m) $500.00
NARDA 3752 Coaxial Phase Shifter, 0-180 deg./GHz, 1-5 GHz $1,000.00
NARDA 3753B Coaxial Phase Shifter, 0-55 deg./GHz, 3.5-12.4 GHz $1,000.00
NARDA 4000-SERIES SMA Miniature Directional Couplers $75.00
NARDA 4226-10 Directional Coupler, 10 dB, 0.5-18.0 GHz, SMA(f) $275.00
NARDA 4227-16 Directional Coupler, 16 dB, 1.7-26.5 GHz, 3.5mm(f) $325.00
NARDA 4242-20 Directional Coupler, 20 dB, 0.5-2.0 GHz, SMA(f) $100.00
NARDA 4247-20 Directional Coupler, 20 dB, 6.0-26.5 GHz, 3.5mm(f) $200.00
NARDA 4247B-10 Directional Coupler, 10 dB, 6.0-26.5 GHz, 3.5mm(f) $200.00
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 562 DC Block, 10 MHz-12.4 GHz, 100 V max., N(m/f) $65.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $165.00
NARDA 768-10,-20 10 dB or 20 dB Attenuator, 20 Watts, DC-11 GHz, N(m/f) $120.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
NARDA 794FM Direct Reading Variable Attenuator, 0-40 dB, 4-8 GHz $375.00
OMNI-SPECTRA 2085-6010-00 Crystal Detector, 1-18 GHz, negative polarity, SMA(m/f) $50.00
PAMTECH KYG1014 WR42 Junction Circulator, 18.0-26.5 GHz $250.00
SONOMA SCIENTIFIC 21A3 WR42 Circulator, 20 dB, 20.6-24.8 GHz $75.00
TRG B510 WR22 Direct Reading Attenuator, 0-50 dB, 33-50 GHz $1,000.00
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 Terminated Crossguide Coupler, 30 dB $200.00
WEINSCHEL DS109 Double Stub Tuner, 1-13 GHz, N(m/f) $150.00
WEINSCHEL DS109LL Double Stub Tuner, 0.2-2.0 GHz, N(m/f) $150.00

COMMUNICATIONS

HP 3780A-001 Pattern Generator / Error Detector, 1 kb/s - 50 Mb/s $1,000.00
HP 59401A HPIB Bus Analyzer $375.00
TEK 1410R NTSC Gen., w/SPG2 sync. generator, TSG7 color bars $800.00
TEK 1411R PAL Gen.,w/SPG12 sync; TSG11 color bars;TSG13 linearity $750.00
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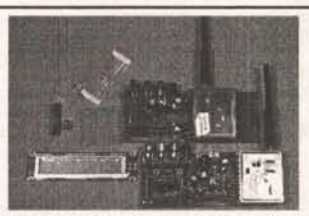

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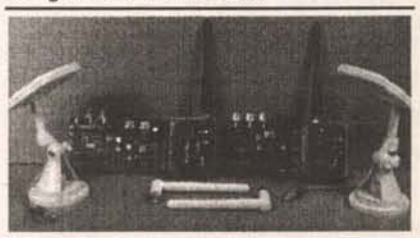

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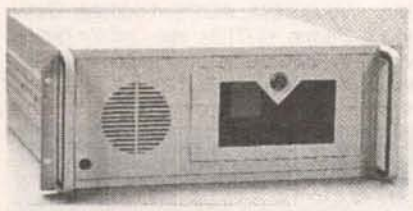

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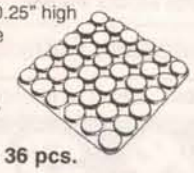

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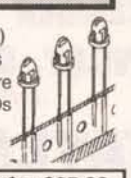

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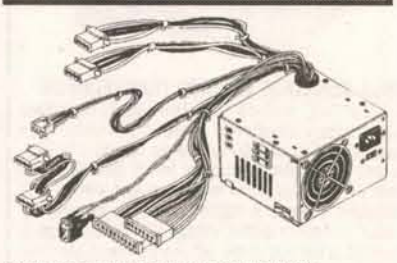

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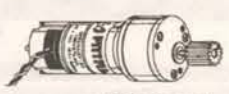

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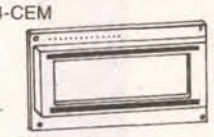

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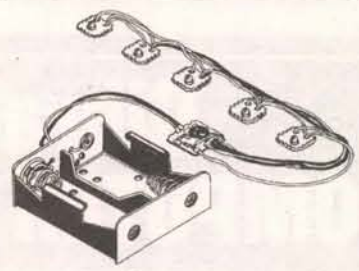

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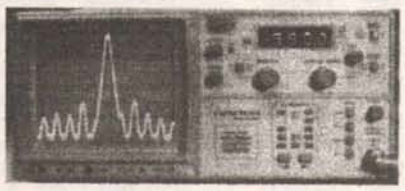

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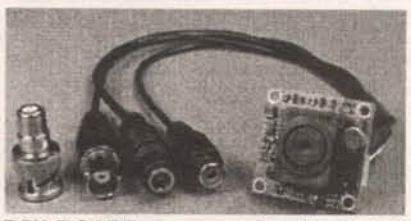

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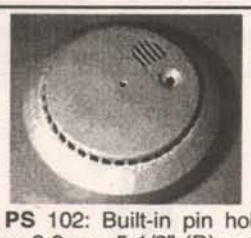

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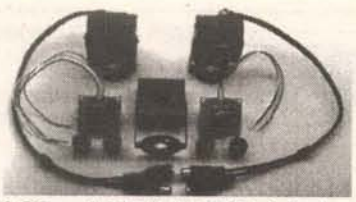

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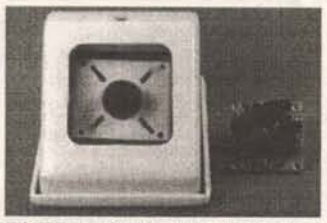

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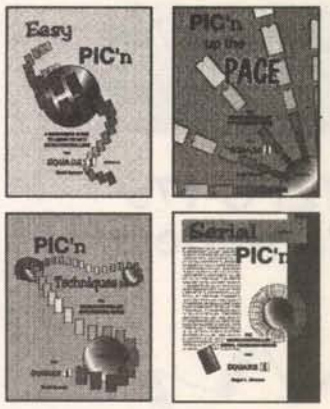

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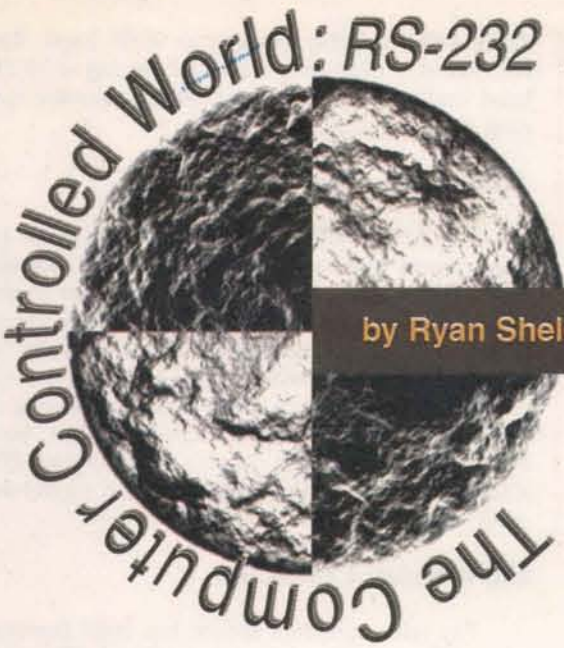

Controlled World: RS-232 Network Control Methods and Applications

Utilizing the BASIC Stamp II SX

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Managing a graphical user interface complete with working buttons, menus, and a user-friendly display, controlled with a simple three-button interface.

When I was 17, my father owned a Porsche 930 Turbo. It had the highly sought-after factory slant nose and had been optimized for performance to the point that it was no-longer street legal. It was rarely driven, as it was one of those few cars that actually appreciated in value. On a quiet summer evening, my dad asked me if I wanted to go for a ride. I had only ridden in it twice before, and was not about to say no.

We went about five miles outside my hometown to a deserted country road where he stopped. He opened the door, pulled the keys out of the ignition (glancing at me with distrust), and walked over to my passenger-side door. As he opened it, he handed me the keys and said, "I know you'll be careful, but I want to remind you that this car is dangerous." I could not believe he was actually letting me drive the very car my brother and I spent hours helplessly drooling over while parked uselessly in our garage.

As I put it in first, I took off rather slowly. When I approached 50 miles per hour, I shifted into second. As the engine started to wind, I shifted into third, but soon had to slow down as I was not use to taking curves in this car. I jokingly asked my dad what fourth gear was for, and he said, "I've only used it a few times myself." I have never driven any car before, or since, with as much excitement and enthusiasm as I had that day.

But now, 10 years later, I no longer get any sort of thrill by driving a machine that can propel you from a dead stop into a tree in record time. I like to think my personal tastes have evolved into something that gives me a different kind of power. But I was recently reminded of that same youthful thrill in the form of Parallax's BASIC Stamp II SX. Similar in that it is fast (very fast), it can be somewhat intimidating (to the inexperienced driver), and it has more program memory than I will ever need (a useless fourth gear of sorts).

The BASIC Stamp — in my humble opinion — is the micro-miracle of the 90s. Without exception, it is the fastest and easiest way to provide a tiny intelligent brain for the toughest of projects. And now, with the release of the BASIC Stamp II SX, the Stamp has been optimized for performance using the latest of available micro-microprocessors.

Like a Porsche 930 turbo, it does not take long to get use to having, and it is addictive in the best possible way. I hope to share my addiction with others because it allows me to do things quickly and easily. And if you've never used the Stamp before, then take comfort in the fact that I have only used it for a total of 10 hours before writing this article.

So why not go full bore and give the Stamp something tough. After all, if you're going to get behind the wheel of a sports car, you better be ready to drive. You're not going to have any fun by driving it like a ninny. So let's use this mighty micro to cause some real trouble. I think I have just the thing ...

The Project

In this project, I will put the Stamp SX in charge of managing a graphical user interface. Not your basic "change full-screen graphic images" kind. This is the real thing, with working buttons, menus, and a user-friendly display, controlled with a simple three-button interface. Oh, and in case I forgot to mention, the user interface has to really do something ... in this application, it has to switch 16 video signals into two monitors and control a bank of eight relays from the three-button interface. And speaking of a useless fourth gear, I managed to get the job done with 10 spare I/O pins, and plenty of free program memory.

Truly GUI

There are some applications where only a true GUI will do (Graphical User Interface, GUI is pronounced "gooey"). The graphical elements shown in Figure 1 are stored as icons, which is basically an image that is divided into a lot of smaller images. The vacuum florescent display controller supports a command set that allows you to position these smaller images just about anywhere on the VFD screen.

Once this page of icons is stored into the VFD controller, the Stamp II SX is used to control how these icons will appear on the screen, strategically positioning each graphical element on the screen to build a user interface. I drew these icons using PhotoShop 5 and I stored them into the VFD display controller using our VFD Loader Utility. Drawing the icons took about an hour, storing them

Figure 1

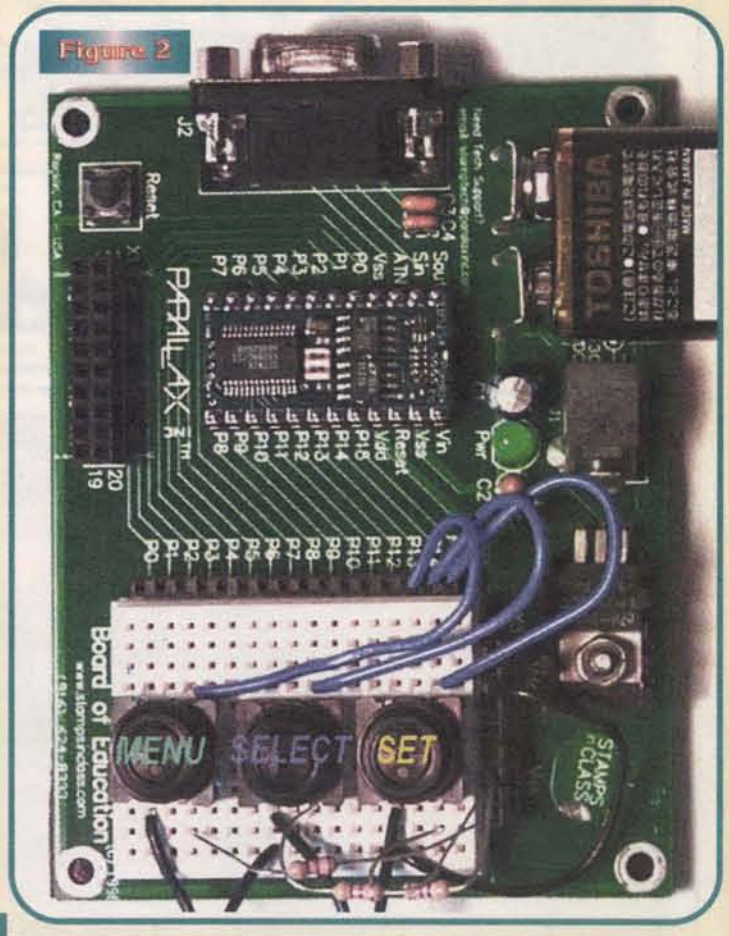


Figure 2

Figure 3

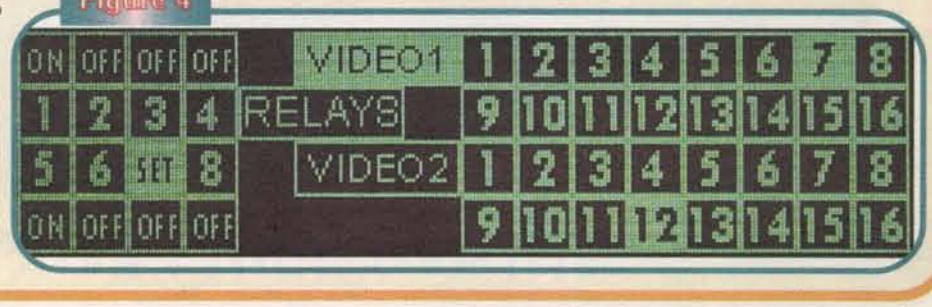


Figure 4

into the controller took about 15 seconds ... this is the very reason why I don't complain about my computers being slow.

The image shown in Figure 1 may be modified by your favorite paint program. It's possible to make the interface look a lot prettier, but I was a little anxious to make it work as I had just received my Stamp II SX from Parallax.

Three-Button Interface

Three buttons are used to switch 16 video signals into two outputs and actuate/de-actuate a bank of eight relays. As shown in Figure 2, the buttons are mounted on Parallax's Board of Education, a rather useful tool for quick prototypes.

The "Menu" button on the left is used to switch menus. Each time the button is pushed, the menu cycles between Video 1, Video 2, and Relays as shown in Figure 3. When the menu is set to Video 1 or 2, the middle and right buttons are used to switch video input sources, up to 16. I will discuss that in more detail later in this article. Figure 4 shows video input 7 routed to video output 1, and video input 12 routed to video output 2.

When the menu button is switched to Relays, the center button is used to select one of the eight relays while the right-most button is used to toggle the selected relay on and off. Figure 4 also shows relays 1 and 5 on. Note that "SET" appears in place of relay 7. Pushing the center button moves the "SET" marker between each of the eight relays.

Wiring External Devices

The BASIC Stamp II SX is wired to three buttons and three external devices, leaving 10 I/O lines available for other functions. Figure 5 shows the wiring of all devices to the Board of Education. The wiring only takes about 10 minutes. The Stamp II SX supports many baud rate options. The Stamp is connected to the ASEL video switcher running at 9600 baud, the R85 five-amp eight-relay controller running at 19.2K baud, and a vacuum florescent display controller running at 38.4K baud.

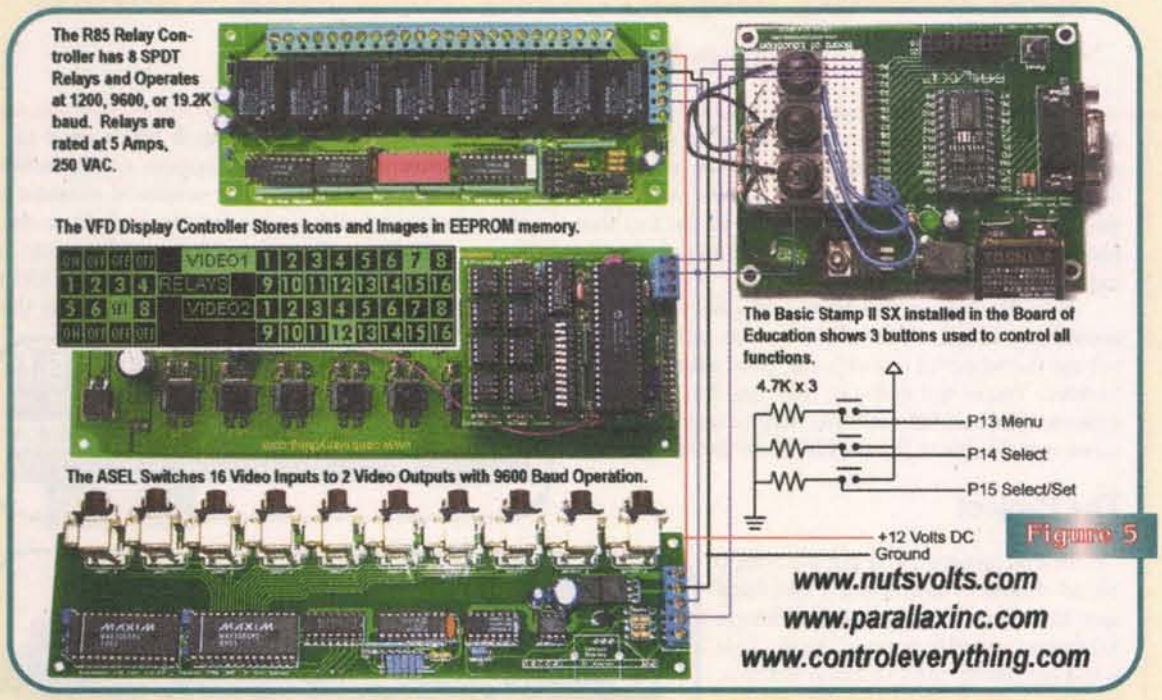


Figure 5

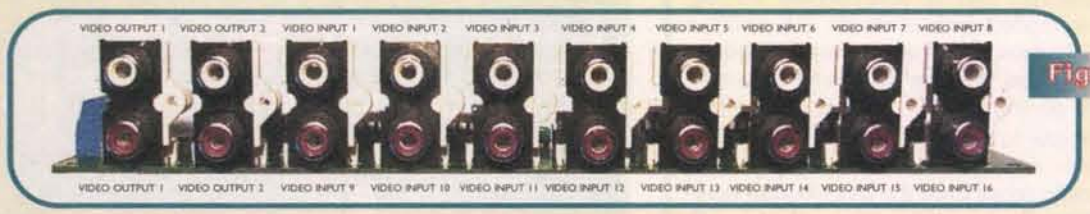


Figure 6

Figure 7

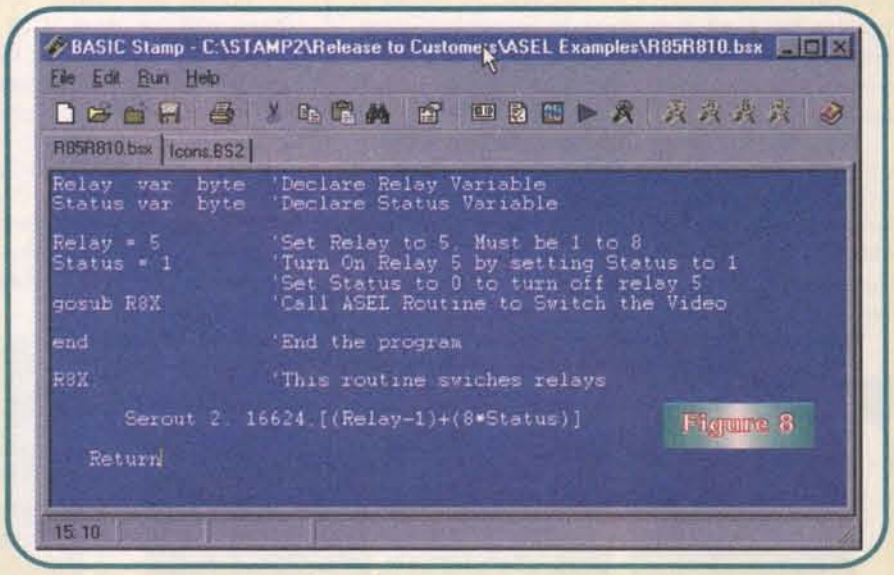


Figure 8

16x2 Video Switching

The ASEL video switcher is used to route 16 video inputs to two video outputs under software control. The ASEL has 16 composite video inputs and two composite video outputs as shown in Figure 6. The ASEL is capable of switching video, audio, or just about any other analog signal source in the ±5-volt range. The ASEL is easily controlled by any of the BASIC Stamp series micro-controllers from Parallax. Any computer capable of generating RS-232 data at 1200 or 9600 baud can also control the ASEL video switcher.

Eight-Relay Controller

The relay controller shown has eight five-amp relays (10-amp relays are also available). The relay controller is ideal for controlling lights, small motors, speakers, telephone lines, or just about anything. External devices can be wired to each relay as normally open (where the device is normally off and switched on) or normally closed (where the device is always on and switched off). The RS-232 input is optoisolated. A third data wire may be connected to the relay controller if your computer needs to ask the relay controller what the current on/off status is of each relay.

VF Display Controller

The vacuum florescent display and controller is capable of storing up to 127 full-screen images, or 123 pages of icons, or any combination of images and icons. The VF display controller is easily controlled using simple ASCII character codes. It is possible to copy stored images to the display screen, plot pixels, scroll images, and use 20 different sizes of icons for large text fonts, complex graphical user interfaces, or animation.

BASIC Stamp II SX Firmware

The firmware can be downloaded from my web site at www.controleverything.com. Go to the "articles" link and download the November 1999, Stamp on Steroids file: NOV99.ZIP. This file contains the template image used for the GUI and the BASIC Stamp II SX source code.

Controlling the ASEL Video Switcher

The BASIC Stamp II SX is used to control the ASEL 16x2 video switcher from the user interface.

THE COMPUTER CONTROLLED WORLD

In an effort to simplify the video switching operations, I have simplified the code so you can get an idea of what must be done to switch video from the BASIC Stamp II SX. Figure 7 was taken from Parallax's BASIC Stamp Editor version 1.091 beta.

Controlling the Relay Driver

The relay driver is also very easy to control from the Stamp II SX. The screen shot shown in Figure 8 provides a few short lines of code to show how it is done:

Controlling the VF Display

Only two commands are ever used to control the vacuum florescent display. The clear screen command is issued when the program is first run, and the Paste Icon command is used to generate the graphical user interface. Figure 9 shows how to send these commands using the BASIC Stamp II SX. The VF display controller supports many other commands such as plotting pixels, brightness adjustment, image/text scrolling, full-screen image copy, as well as many text functions.

While any of Parallax's BASIC Stamp series micro-controllers can control the VF display, I would recommend using the BASIC Stamp II SX version. Its high processor speed means shorter character spacing, making it noticeably faster for most display operations.

Accessing the Buttons

The Stamp also has a very powerful button function, allowing you to monitor and de-bounce inputs using a single instruction. Because I am inexperienced in using most of the Stamp's functions, I chose to write my own code for this rather than spend any time learning how their command works. Figure 10 provides a stripped-down version of a program that I used to monitor each of the three buttons. When a button is pressed, the program waits for the user to release the button before an operation is performed.

Program Logic

One thing that I have always taken for granted when programming on a desktop computer is that I can often be lazy about how I write my code. Because so many resources are available to me on a desktop computer, I can write routines that are rather inefficient, require less thinking, and usually use up more code space. This is not good programming practice when using a microcontroller such as the BASIC Stamp. But because I was pressed for time, I thought I would give it a shot just to see how the Stamp II SX holds up. The routine shown in Figure 11 is used to change menus every time the menu button is pushed (see Figure 3 to see how the graphics change when the menu button is pushed). Pasting stored icons onto the VF screen changes the menu.

If I were to write this routine efficiently, it would only redraw the images that actually change on the screen. Instead, I chose to scrap the use of logic and clear all buttons, then draw the menu item that was selected. This means the Stamp has to do twice as much work, but only uses a few logic instructions to get the job done. Surprisingly, the menu button is VERY responsive. The Stamp and display keep up with normal to fast button presses with little effort.

I hope you have enjoyed this month's article, maybe even learned a little something. I know I have. I would like to encourage you to call or write if you have any questions about this or any of my previous articles. Feedback is always welcome and encouraged. Or, if you have a story idea, just let me know. If I like it, I'll run with it. **NV**

```
Screen      var   nib    'Screen Number (1-4)
Frame       var   byte   'Frame Number (1-15 typical  1-127 with fully expanded memory)
Icon        var   byte   'Icon Number (0-255 depending on number of available icons in a given frame)
X           var   byte   'X Position (0-255)
Y           var   byte   'Y Position (0-63 for the VFPlot Command  1-8 for all others)

main                                'Paste an Icon on the Screen
      Screen = 1                    'Set Display Screen to 1
      Gosub ClearScreen             'Clear Display Screen 1

      Frame = 17                    'Frame 17 Holds a Page of icons shown in Figure 1
      Icon = 0                      'Icon 0 is the "1" in the upper left corner
      Screen = 1                    'Icon will be pasted on screen 1
      X = 0                         'X is the horizontal position from 0 to 255
      Y = 1                         'Y is the vertical line from 1 to 8 (8-pixel increments only)
      Gosub PasteIcon               'Paste Icon onto the VF Screen

end

ClearScreen                                     'Clear Screen (Screen 1-4)
    SerOut 0, 16429,[254, 46, Screen]           'Clear Display Screen
    Pause 100                                   'Wait for Controller to Finish
Return

PasteIcon                                       '(Frame 5-127, Icon 0-255, Screen 1-4, X 0-255, Y 1-8)
    SerOut 0, 16429,[254, 75, Frame, Icon, Screen, X, Y]    '254, Enter Command Mode
                                                '75,  Paste Icon Command
                                                'Send Parameters for Paste Icon Command
    Pause 10                                    'Wait for Controller to Finish Operation
Return
```

Figure 9

```
input 13    'Set Stamp Pins 13, 14, and 15 as Inputs
input 14
input 15

main                            'Wait for a button press
      if in13=1 then btn1       'If Button 1 is pushed
      if in14=1 then btn2       'If Button 2 is pushed
      if in15=1 then btn3       'If Button 3 is pushed

goto main                       'Monitor Buttons

      btn1
            debug "1"           'Tell user button 1 was pushed
            goto bclr           'Wait for user to release button

      btn2
            debug "2"           'Tell user button 2 was pushed
            goto bclr           'Wait for user to release button

      btn3
            debug "3"           'Tell user button 3 was pushed
            goto bclr           'Wait for user to release button

bclr                            'Wait for user to release button
      if in13 = 1 then bclr     'This portion of the program
      if in14 = 1 then bclr     'goes into a continuous loop
      if in15 = 1 then bclr     'if any of the 3 buttons are pushed

      goto main                 'Otherwise, the program restarts
```

Figure 10

```
SetMenu
        Pause 10: Serout 0, 16429,[254,75,16,35,1,80,1] 'Turn Off Video 1 Button
        Pause 10: Serout 0, 16429,[254,75,16,36,1,96,1]
        Pause 10: Serout 0, 16429,[254,75,16,37,1,112,1]

        Pause 10: Serout 0, 16429,[254,75,16,38,1,80,5] 'Turn Off Video 2 Button
        Pause 10: Serout 0, 16429,[254,75,16,39,1,96,5]
        Pause 10: Serout 0, 16429,[254,75,16,40,1,112,5]

        Pause 10: Serout 0, 16429,[254,75,16,32,1,64,3] 'Turn Off Relays Button
        Pause 10: Serout 0, 16429,[254,75,16,33,1,80,3]
        Pause 10: Serout 0, 16429,[254,75,16,34,1,96,3]

        If Device = 1 then OnVideo1
        If Device = 2 then OnVideo2
        If Device = 3 then OnRelay
        If Device > 3 then MaxDevice

    OnVideo1
        Pause 10: Serout 0, 16429,[254,75,16,51,1,80,1] 'Turn On Video 1 Button
        Pause 10: Serout 0, 16429,[254,75,16,52,1,96,1]
        Pause 10: Serout 0, 16429,[254,75,16,53,1,112,1]
    Return

    OnVideo2
        Pause 10: Serout 0, 16429,[254,75,16,54,1,80,5] 'Turn On Video 2 Button
        Pause 10: Serout 0, 16429,[254,75,16,55,1,96,5]
        Pause 10: Serout 0, 16429,[254,75,16,56,1,112,5]
    Return

    OnRelay
        Pause 10: Serout 0, 16429,[254,75,16,48,1,64,3] 'Turn On Relays Button
        Pause 10: Serout 0, 16429,[254,75,16,49,1,80,3]
        Pause 10: Serout 0, 16429,[254,75,16,50,1,96,3]
    Return
```

Figure 11

SOURCES:

BASIC Stamp II SX, Board of Education
Parallax, Inc.
3805 Atherton Road, #102
Rocklin, CA 95765
Phone: (888) 512-1024
FAX: (916) 624-8003
www.parallaxinc.com
info@parallaxinc.com

ASEL Video Switcher, R85 Relay Controller, VF Display/Controller
National Control Devices
P.O. Box 455
Osceola, MO 64776
Phone: (417) 646-5644
FAX: (417) 646-8302
www.controleverything.com
ncdryan@aol.com

REVIVING NICAD-POWERED DEVICES

by Kenton Chun

Here is an interesting exercise: One day when you have copious amounts of free time, try counting the number of batteries in your house. This means counting every battery, including the one that backs up the clock in your digital refrigerator.

I tried this once and never completed it – I literally lost count somewhere near 200 batteries! Believe it or not, this is average for a hardware hacker. With all of the batteries in our lives, it is natural that a growing number of them will be rechargeable NICADs (NIckel-CADmium).

Portable power tools, test instruments, laptop computers, and portable phones usually top the list of common rechargeable devices in our homes and offices. The sealed nicad cell is an electrochemical system which converts, in a reversible way, chemical energy into electrical energy. To accomplish this, the nicad battery uses a nickel positive electrode with a cadmium negative electrode in a potassium hydroxide electrolyte.

Nicads are strange animals. We often kill them with kindness. Unlike their lead-acid cousins, they really don't like to be kept charged up all of the time. Unfortunately, it is far more likely we will do exactly that – a rechargeable screwdriver is usually left in its charging stand until we need it. The problem is that nicad batteries are notorious for developing the dreaded "memory effect." Nicads suffering from the "memory effect" will appear to be fully charged, but when a load is drawn off them, will quickly drop below their rated capacity and die out. This phenomenon is not as much a characteristic of nicads in general, but more because of the way they are packaged. Usually nicad battery packs are a set of individual cells wired in series and wrapped in a plastic sleeve. The batteries are charged and discharged in series. If a single cell in the pack becomes weak, shorts out, or opens, the entire pack is rendered useless.

Even worse, many appliance manufacturers glue the pack into a proprietary plastic case which only fits the device it is intended to power. The net result is that when these batteries fail, either the entire battery pack or the device itself is discarded. The terrible irony is that doing this can negate any advantage of purchasing a rechargeable device in the first place!

Walk through a hamfest or a flea market, and you will literally find hundreds of wonderful devices suffering from nicad battery failure at bargain prices.

Our project this month is to look at some ways we can salvage these from the scrap heap and recycle them back into active duty. Dig through your toolbox and electronic junkbox, and pull these out for another look.

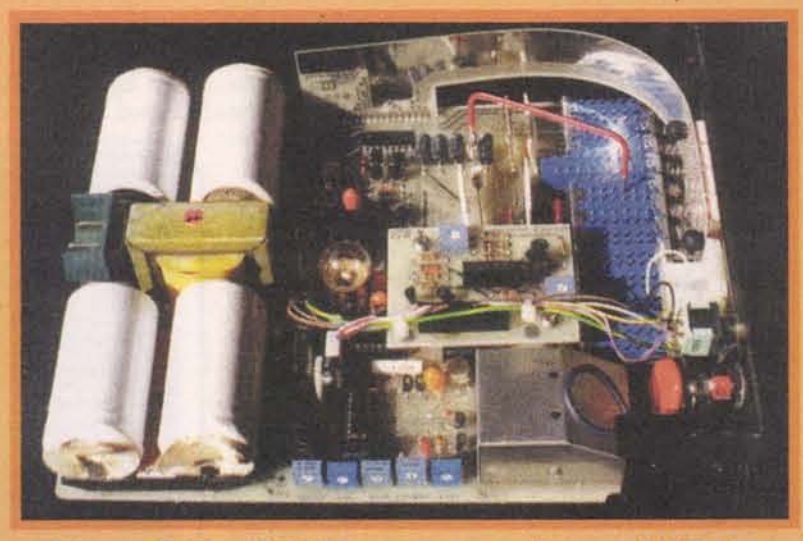


Figure 2: Dead Fluke meter, needs new NiCads.

NICAD WAKE-UP CALL

After many cycles of operation, nicads often develop small internal short circuits as the potassium hydroxide electrolyte forms tiny "dendrites" which bridge the nickel-cadmium electrodes. These shorts inhibit the cell's ability to achieve a full charge. When this happens, the cell is usually discarded.

One of the simplest ways you can breathe new life into a "dead" nicad battery pack is to hit it with a short duration overvoltage. One of my favorite tricks is to take a 12-volt power supply with a good current rating of several amps and connect it across the nicad battery pack in series with an old metal file. By dragging the positive lead across the file, you send intermittent high-current spikes through the battery pack, burning off any internal shorts in the batteries. Many times the battery pack will accept a charge after this seemingly rough treatment (Figure 1). This works on battery packs from 4.8 volts to 9.6 volts. Use a higher voltage supply for higher-voltage battery packs.

Be sure to wear eye protection when performing this operation!

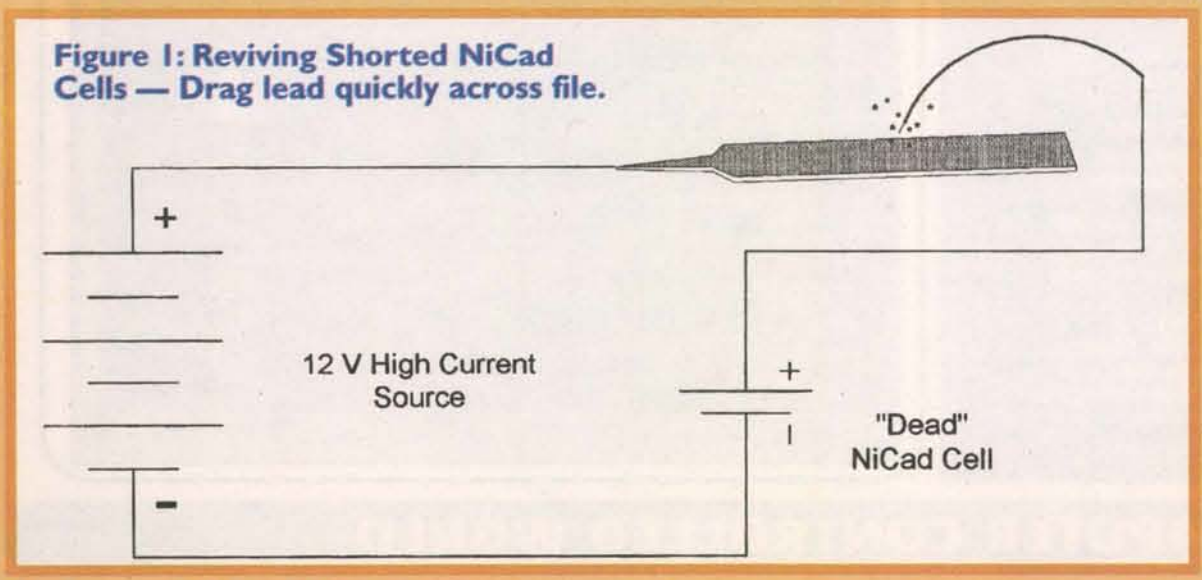


Figure 1: Reviving Shorted NiCad Cells — Drag lead quickly across file.

REPLACEMENT

If a cell fails to open, or shows obvious signs of electrolyte leakage, it is a total loss. Your choices here are to either replace the defective cell, or the entire battery pack. Battery packs that are sealed in a plastic sleeve can often be accessed by carefully slitting the sleeve open with a razor blade, exposing the individual cells. If the pack is in a hard plastic shell, it may be possible to cut the shell open with a Dremel tool, or even carefully pry it apart along the glue line with a screwdriver. Camcorder and cellphone batteries often are constructed in this manner.

One good tactic is to purchase a battery pack for the device which is designed for standard alkaline batteries and fill it with nicad cells instead. This will allow you to test and replace individual defective cells in the future, instead of throwing away entire (mostly good) battery packs. Because nicads are rated at 1.2 volts instead of 1.5 for disposable alkaline batteries, it may be necessary to check and make sure the device will still function properly on the slightly lower voltage of the combined nicad pack. It usually will for anything less than a 12-volt battery.

CONDITIONING

Newer nicad battery chargers employ a "conditioning cycle" which is little more than a controlled discharge of the battery pack through a load before the charging cycle commences. The reason for this is to allow all of the cells to reach a completely discharged state before they are recharged. In a series-connected battery pack, some cells are likely to discharge before others. The weak sisters may actually charge negatively if the remaining cells continue to push current

through the pack under a big load.

Stronger cells may not become completely discharged before the total pack voltage drops below nominal operating voltage for the device it is powering. Discharging the pack completely will help ensure that all of the cells will have an opportunity to be charged equally. You can simulate this by connecting the battery pack to a suitably-rated light bulb and waiting until the light goes out before recharging the battery pack.

EXAMPLES

Take a look at the Fluke 8000A multimeter I picked up at a local hamfest for $5.00. When plugged into AC power, it emitted a high-frequency whine, and displayed random digits. The seller had decided it was a total loss. However, when I opened it up, I discovered it was powered by four "D" nicads floating across a constant charging supply when plugged into AC utility power.

The high-frequency charging supply had insufficient output to run the meter. Since it had not spent much time in portable use, the constant AC charging supply had literally cooked the batteries. The nicads were visibly leaking and read no voltage at all. Because the multimeter depended on the batteries to provide the DC operating voltage, the failure of the batteries caused the meter to quit operating. Replacing the nicads put the meter back on the workbench (Figure 2).

Many low-cost power tools have internal nicad battery packs. My 10-year-old Sears electric screwdriver and 3/8" portable drill began to show symptoms of nicad failure when an all-night charge only yielded five minutes of run time. Using a torx screwdriver to open the cases revealed internal battery packs consisting of "C" size cells which were easily replaceable, saving these two tools from the landfill. With luck they may last another 10 years (Figure 3).

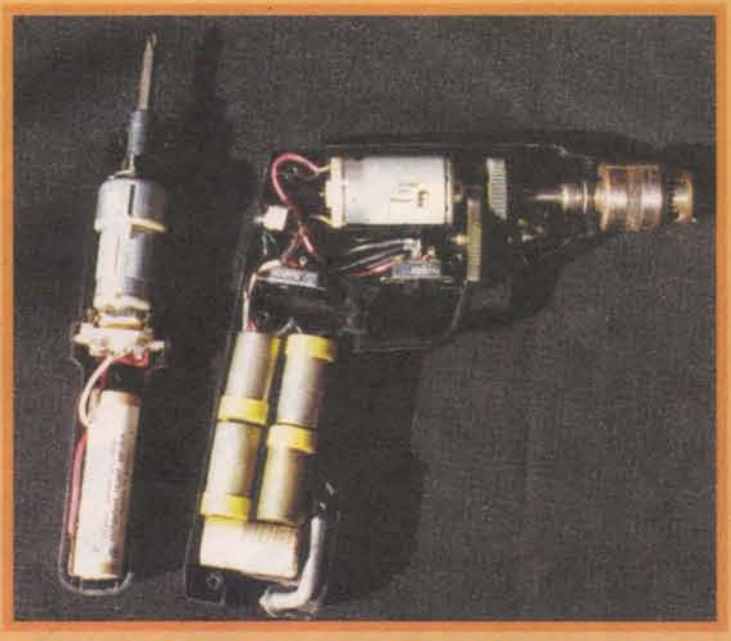


Figure 3: Don't toss out "dead" power tools, repair them!

CHARGING NICADS

Cyclic Use:

It is recommended that nicads be charged at semi-constant or constant current charging at the 0.1 I (I/10) rate for 15 hours. Overcharging at I/10 for long periods of time can be done at room temperature without causing damage. For example, a 1200 mAh nicad can be charged at 120 mA for 15 hours or longer. Using Ohm's Law, a five-volt charging supply would need a 42-ohm resistor in series with the nicad cell to deliver this current (E/I=R, so 5/.120 = 41.66Ω).

Cell sizes ranging from 1/3AA to SC can also be quick-charged for 4.5 to six hours at the 0.25 I (I/3- I/4) rate. Quick-charging larger cells (C-cell and up) requires a controlled charge circuit because of the heat and gas generated during overcharge.

Stand-by Use:

A trickle charge between 0.02 I and 0.05 I (I /50- I/20) is sufficient to keep a battery fully charged. At 0 degrees Celsius to 45 degrees Celsius (32 degrees F to 113 degrees F), this charge rate will minimize heating effects during overcharge and prolong battery life.

The most common problem with inexpensive rechargeable tools is that there is no current limiting in the charger. Keeping nicads on constant high charge will eventually heat them up until they self-destruct.

A cheap and dirty method of limiting current to nicads in standby charge mode is to insert a light bulb (or suitable series resistor) in series with the charger. The light bulb filament will gradually dim and increase its resistance as the battery pack reaches full charge and thereby tapers off the supply current to the battery pack. You may need to experiment with various light bulbs until you find one that exhibits the correct charging characteristics.

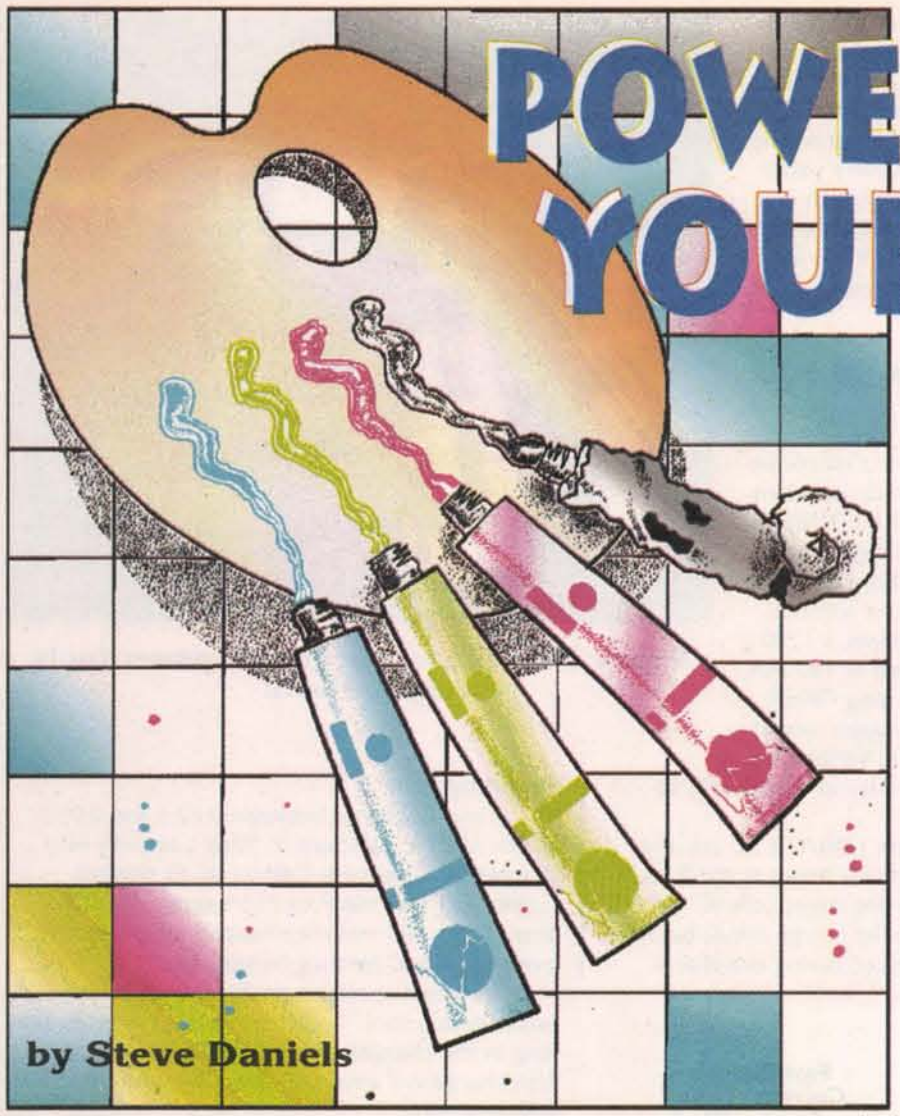
Proper care and maintenance of nicads will allow hundreds of recharge cycles. They are an environmentally-friendly alternative to continuously disposing of alkaline or carbon-manganese batteries. With occasional replacement, the devices they power can be used almost forever. Certainly, if you have over 200 batteries to replace, nicads make good sense!

Remember, have fun whatever you do! NV

Nickel Cadmium Standard Cell Specifications*

Size	Capacity mAh	Dia. (mm)	Height (mm)	Weight (gm)	Charge Current (mA) 1/10	Fast Charge Current (mA) 1/3	Fast Charge Time (Hrs)
1/3 AAA	50	10.5	16.0	3.5	5	15	4-6
1/3 AA	110	14.5	17.0	8.0	11	33	4-6
N	150	12.0	29.5	9.0	15	45	4-6
AAA	200	10.5	44.5	10.0	20	60	4-6
1/3 AF	225	17.0	17.0	12.0	23	340	7-8
2/3 AA	270	14.5	30.0	14.0	27	400	1
2/3 AF	500	17.0	28.0	20.0	50	750	1
AA	600	14.5	50.0	24.0	50	900	1
1/2 SC	650	23.0	26.0	29.0	65	945	1
4/5 SC	1000	23.0	34.0	42.0	100	1500	1
3/5 C	1100	26.0	30.0	44.0	110	1650	1
AF	1200	17.0	50.0	34.0	120	1800	1
SC	1400	23.0	43.0	53.0	140	2100	1
C	2000	26.0	50.0	75.0	200	—	—
1/2 D	2300	34.0	38.0	80.0	220	—	—
2/3 D	2500	34.0	44.0	110.0	250	2500	1
D	4000	34.0	61.0	160.0	400	6000	1
F	7000	34.0	91.0	230.0	700	—	—
SF	10,000	43.0	91.0	400.0	1000	—	—

*There may be slight variations in overall length and height of cells due to differences in mounting tabs and contacts, and in the thickness of cell coverings.



POWERPOINTING YOUR PROJECTS

Part 3

by Steve Daniels

Last month, we built a template in PowerPoint for doing layout drawings and PC board etch patterns. This month, we will put the template to use by doing a board layout for the schematic that we created in Part 1 (see Figure 1). Then we will produce an etch pattern, create a PC board, and mount it in an enclosure. The finished device will be

From Idea to Project

Before we begin to lay out a board, we need to go through several essential planning steps.

*** Make sure that the circuit works**

This usually involves setting it up on a breadboard like the one shown in Figure 2.

The prototype board provides a convenient way to quickly make changes in component values or in the circuit design, and it has built-in buses and terminations for a power supply.

*** Do a first cut at the final layout**

The template will give us the ability to move component outlines around on-screen, but it is still a good idea to work things out on the breadboard beforehand. In doing your layout, think first about the terminations going off the board — to switches, controls, batteries, and the like — and position these first. Then locate the rest of the components to accommodate the external connections.

Remember that our PC board will have two levels: a component side and a solder side. While this means that the designer must think on two levels, it also makes prototyping easier.

You can run connections under components, anticipating that these will later be traces on the solder side of the board. Note the wires going under the chips in Figure 2.

*** Select an enclosure and figure out the dimensions of the board**

The application will dictate the kind of case. The amount of space that the components occupy on the breadboard will indicate how big the case should be and how big a board is needed. I chose a standard plastic case available from RadioShack and measured inside it to figure out how large a board it would accommodate.

Now that we have a possible layout and know the size and shape of the board, we can create an "x-ray" drawing. This drawing will show both the components and the interconnecting wiring. Open the template and save the file with a new name. Leave Snap To Grid off and start with Zoom at 200%. Now see Figure 3.

a) Using the guides to establish the size, draw an outline of the board. I usually draw individual

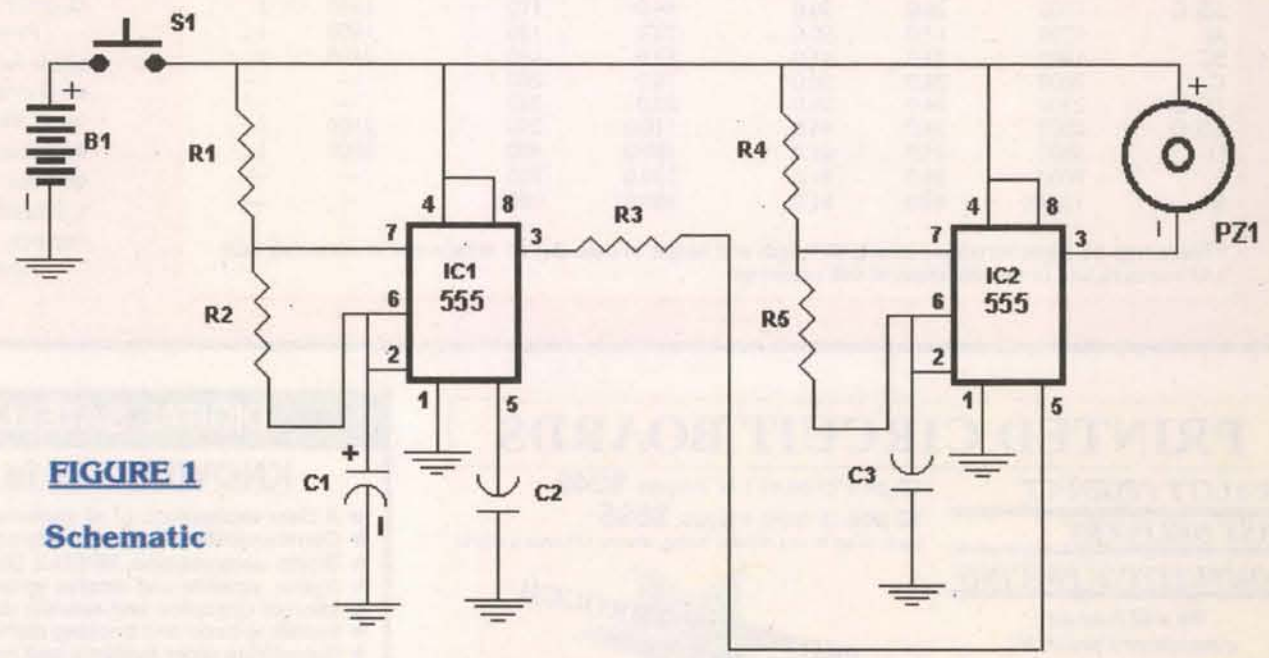


FIGURE 1

Schematic

R1 - 8.2K
R2 - 33K
R3 - 1K
R4 - 4.7K
R5 - 10K

C1 - 22 mfd. electrolytic
C2 - .01 mfd. mylar
C3 - .05 mfd. mylar

S1 - SPST Pushbutton
PZ1 - Piezoelectric Speaker Element, Radio Shack 273-091 or similar
B1 - 9 volt battery

FIGURE 3: Draw the Outline of the Board

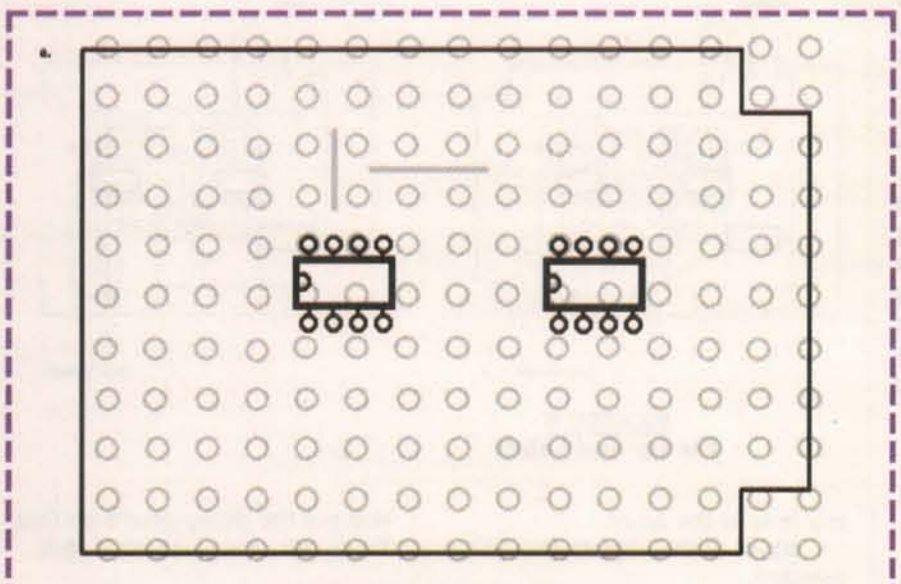


FIGURE 4: Add the Chips

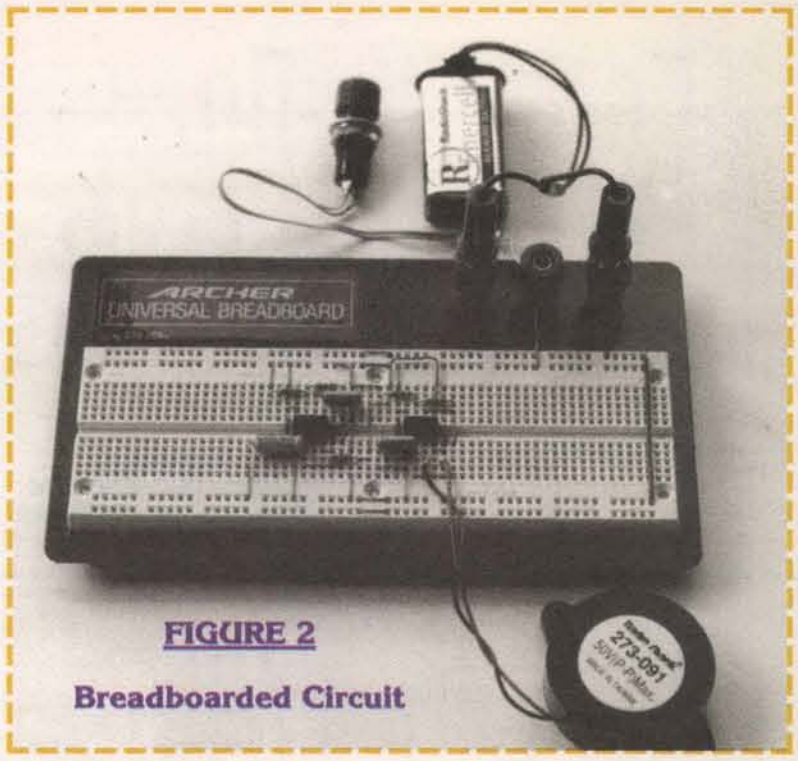


FIGURE 2

Breadboarded Circuit

lines as shown and group them rather than drawing a polygon.

For convenience, place the outline more or less in the center of the array. Hide the guides.

See Figure 4.

a) Begin to populate the board by copying two eight-pin DIP outlines and two trace lines from the library area and placing them within the board outline. Use the holes of the array to orient the chips with respect to each other. This board won't be very tightly packed, so "eyeball" positioning of the chips is okay; if it were more complicated, you might want to do some measuring with the guides to establish exact locations. It should be clear now why I emphasized No Fill for the component outlines: You have to be able to see through to the holes in the array and to the traces that we will add in the next step.

See Figure 5.

a) Establish the lines connecting pin 4 and pin 8 of each chip by copying horizontal and vertical line segments as needed and moving them into place.

b) This shows a typical shortcut.

c) When you have made the connections, bring the chip outlines to the front.

Now let's look to place the pads for the off-board items: the switch, the battery clip, and the piezo element. The top left seems a reasonable area for the first two since the battery clamp is on the left side of the case. The connections for the element should go on the lower left near pin 3 of IC2.

See Figure 6.

a) Do you remember how you were cursing under your breath at all the finicky details of making the template? It pays now, doesn't it! If you went all the way, you should even have the polarity symbols available.

b) Draw traces to these pads now and add the traces for the power to the chips. We'll make adjustments later, if necessary, but it is around these connections that we will work out everything else. Always bring outlines and pads to the front as you connect traces to them.

Now we can add components and wire.

See Figure 7.

a) Refer to your breadboarded layout when you are positioning component outlines. If you were careful to run traces under components where necessary, things should fall into place. The negative side of the electrolytic falls on top of the ground trace, so just shorten the trace, terminate it on the top side of the pad, and continue from the bottom side.

b) Wire the components together. With practice, it will become clear where you should just extend a line to make a connection and where you need to draw a new one.

Yes, I know that I changed a number of traces that we had laid down in the beginning; I said that we might have to, remember? Let's take a look at what changed and

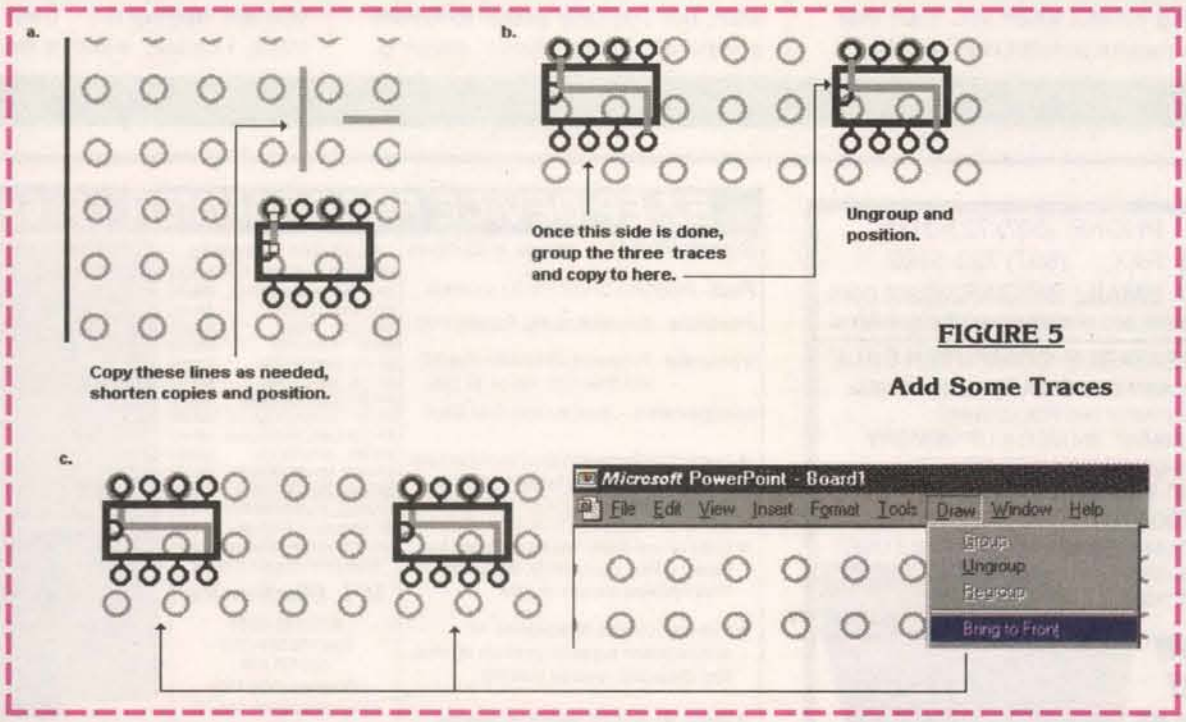
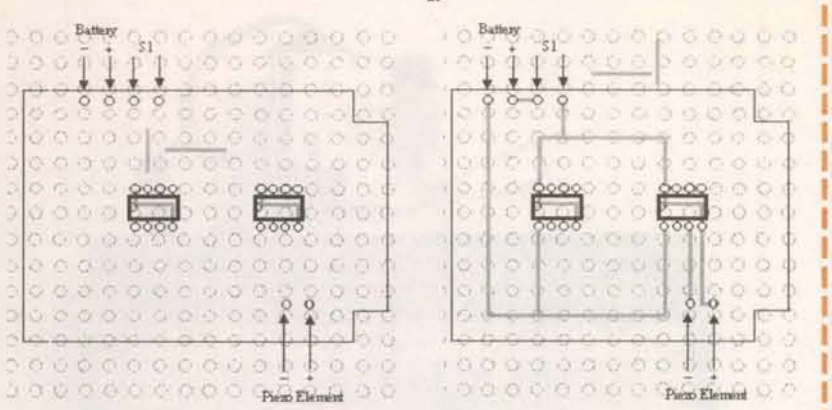


FIGURE 5

Add Some Traces



Copy some standard pads and duplicate. Locate and label.

FIGURE 6
Locate the Off-Board Connections and Power

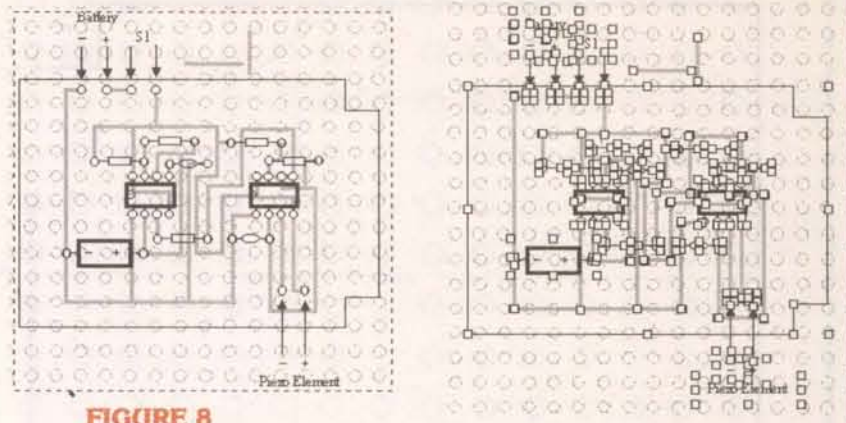


FIGURE 8
Create an "X-Ray" Drawing

Select everything

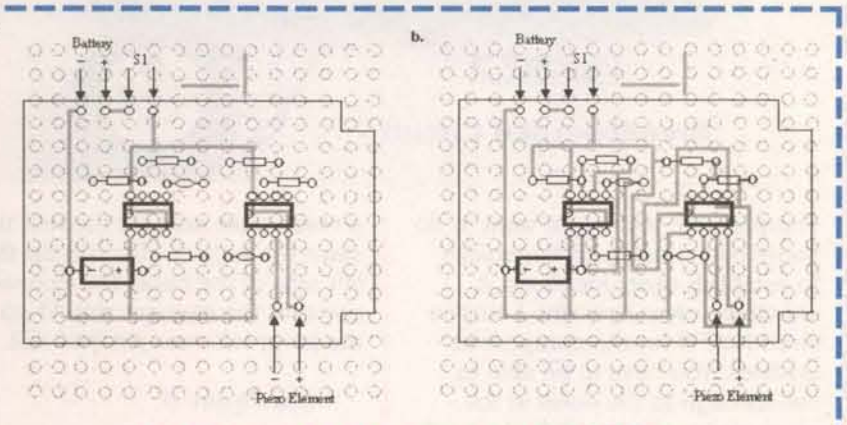


FIGURE 7: Add the Components and Wire

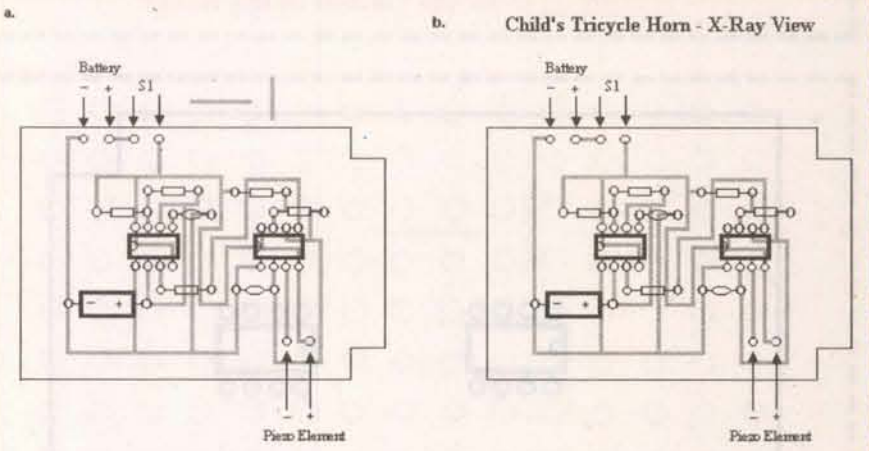


FIGURE 9
Fix Up and Label

why, because the changes illustrate very typical problems in board design.

As the schematic shows, we need to get the output from pin 3 of IC1 to the control voltage input, pin 5, of IC2. This is not possible without using jumpers if the trace carrying V+ to pin 8 of IC2 remains where it is in Figure 7(a). By threading that trace under the resistor going to pin 3 of IC1, we leave a path open to the top row of IC2. The other big change from the breadboard layout was routing the trace connecting pins 2 and 6 of IC2 under the chip; this required redrawing the trace connecting pins 4 and 8. Now everything routes easily.

You won't always be able to avoid jumpers — especially as your boards get larger — but you can minimize the number by planning carefully and using a little creativity with the template.

What we have at this point is an "x-ray" drawing; it shows both the layout of parts on the component side and the traces underneath the board. Let's start to turn this into a finished drawing.

See Figure 8.

a) "Rubber Band" all of the objects that comprise the board, being careful when you start that the mouse pointer isn't touching any hole in the array.

b) All of the objects should be selected.

See Figure 9.

a) Group all the objects. Create a new slide and copy the grouped objects to it.

b) Now ungroup the drawing, remove the un-needed sample traces and label the slide.

You may add designations to the components at this point if you wish, but I usually prefer to create a separate "parts layout" drawing and put the designations on that. To do this, create another slide.

See Figure 10.

a) Copy the drawing from Figure 8 to this slide. Ungroup it and delete the connecting lines. You may find that you need to increase the zoom and rubber band some objects to remove traces that are underneath component outlines. One caution at this point: It is easy to accidentally move a component outline while you are zipping from trace to trace. I usually select a few traces

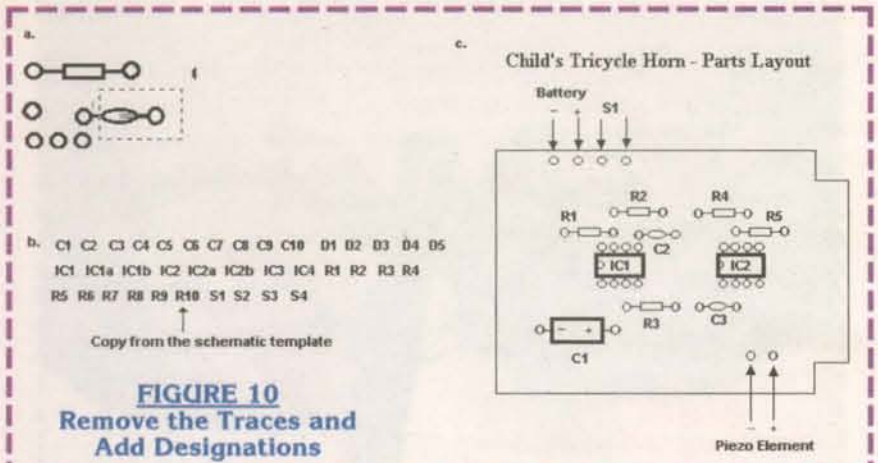


FIGURE 10
Remove the Traces and Add Designations

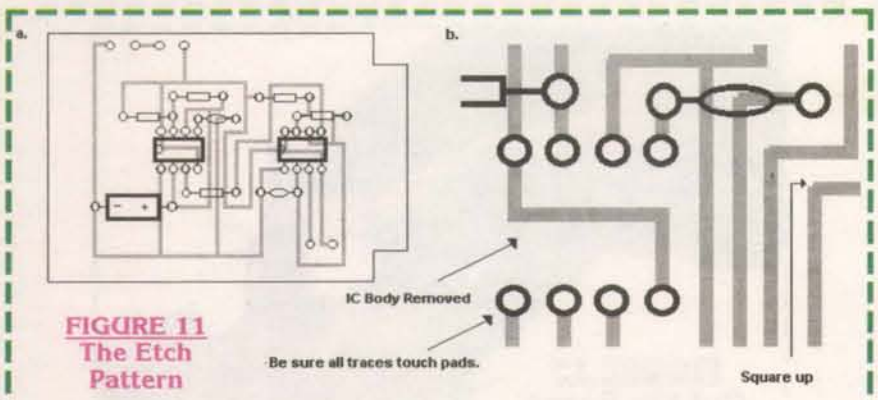


FIGURE 11
The Etch Pattern

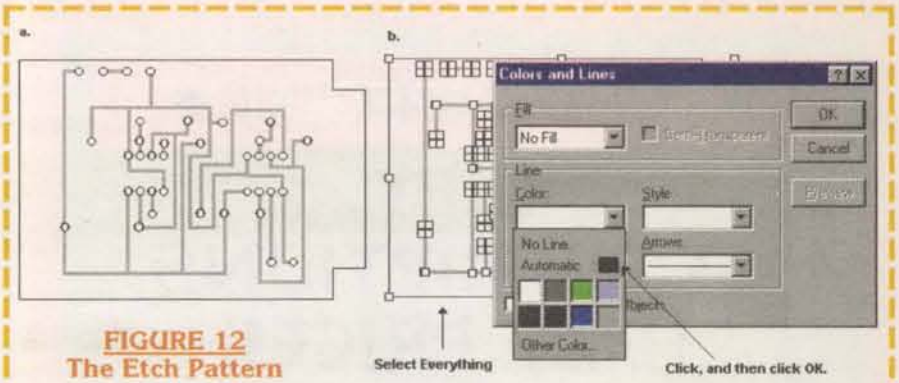


FIGURE 12
The Etch Pattern
continued

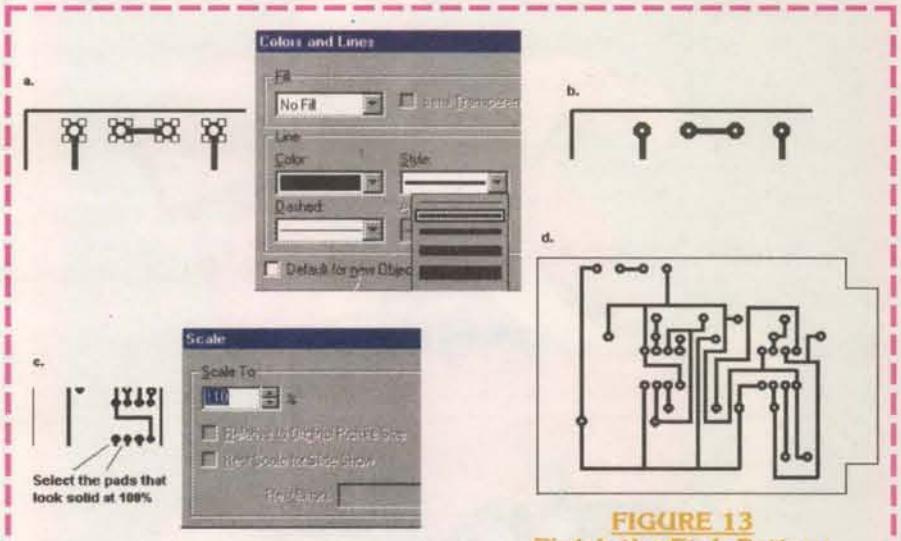


FIGURE 13
Finish the Etch Pattern

at a time, delete them, and then save my work before deleting any more.

b) We created some designations back in the schematic template, so grab a handful of these and copy them to the slide.

c) Designations in place, slide labeled.

Betcha thought we would never get around to creating an etch pattern ... it is done in the same way that we created the parts layout, only we delete the component outlines. To be more precise, we delete the bodies of the components, but leave their pads, since they indicate where to drill.

See Figure 11.

a) Copy the x-ray view drawing to a new slide and remove everything external to the trace pattern.

b) Go to 400% zoom. Ungroup one outline at a time and delete each component body. Be patient ... you do not want to accidentally move any of the pads that you were so careful to set up.

See Figure 12.

a) Now we have an etch pattern.

b) Change the color of all the traces to black. I was able to do this in one step by rubber-banding everything and clicking as shown in Format/Colors and Lines.

See Figure 13.

a) Now select all the pads and change the line style to the second thinnest.

b) This is what they look like at 200% zoom; at 100% some will look solid.

c) Since it is nice to be able to view our drawings at 100%, select all of the holes that still look solid at this zoom level and scale them up 10%. Doing this also gives us a more easily visible hole when the pattern is printed.

d) Try printing the slide. If the result looks like this, let's make a board!

There are about as many ways of transferring an etch pattern to a board as there are hobbyists. A way that works for simple boards and isn't technically complex begins with printing the pattern to transparency film such as you can get from any stationery store. Now use a steel rule and a scribe to mark the outline of the board on a piece of single-sided copper clad phenolic (Figure 14). Use a nibbling tool to cut the piece to size (Figure 15). The material in the photos came from a RadioShack kit p/n 276-1576, which also contains etchant, a resist pen, and solvent for stripping the resist (Figure 16). The plastic case that holds these items doubles as a bath.

Clean the board thoroughly using a sponge and a little household cleanser (Comet or similar), and dry it. Now you want to tape the board over the etch pattern

FIGURE 14
Scribing the Shape of the Board

FIGURE 15
Cut the Board to Size

(Figure 17) using ordinary transparent tape. If the text on the slide isn't backwards, you have the correct side up. Now turn the whole works over (Figure 18) and use a scribe to put a dent in the copper to mark the center of each pad.

Peel the board away from the drawing, but keep the drawing in front of you as a guide (it will be upside down now). With the resist pen, duplicate the drawing pattern on the copper (Figure 19). Your pads need not be perfectly circular, because the dents we made will position the drill precisely later. Do use a steel rule to help keep your lines as straight and thin as possible. Follow the directions that come with the kit to etch the board and strip the resist ink.

Drilling and Stuffing

The kit comes with a 1/16th inch drill bit. This is fine for many of the larger holes that you will sometimes need to drill in a board, but it is too large for small component leads and IC pins. I use a number 59 drill and my trusty Dremel tool. Drill through each

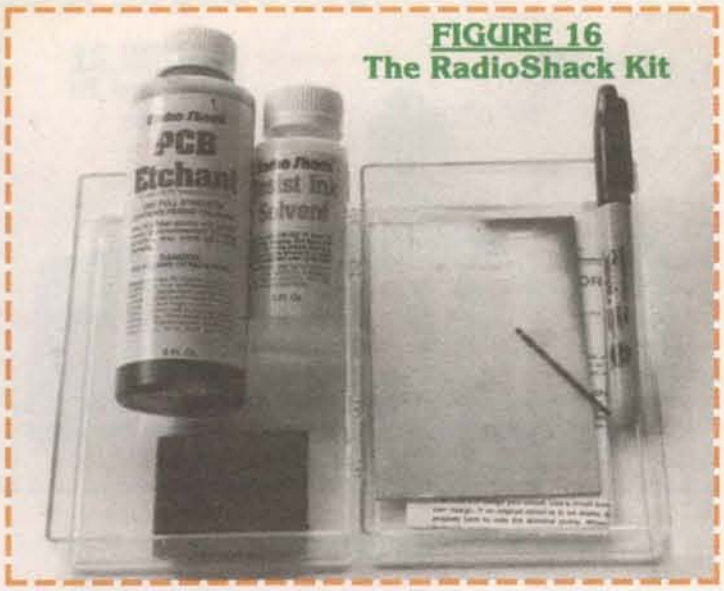


FIGURE 16
The RadioShack Kit

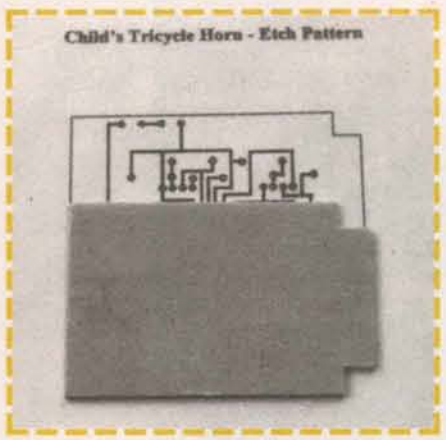


FIGURE 17
Tape Down the Board

pad exactly where you made the center indentation earlier. Figure 20 shows the completed board, stuffed and ready to mount in a box. You will notice that the leads to the piezo element and the battery clip are tacked to the board with epoxy cement. This is just a precaution to keep them from breaking, because they take a good deal of flexing during assembly.

See Figure 21.

I mounted the works in a RadioShack plastic box that I had in my stock. This one has been pulled from their stores but, if you want to duplicate what you see, you can still get it through the RSU (RadioShack Unlimited) program. You ask for part number RSU 11907698, pay for it at the store, and they ship the item to your home in a few days. I have tried this service for a few things in the catalog, and it has worked as advertised.

The piezo element is screwed to the case with 4-40 hardware. The board is mounted on a pair of female standoffs, RadioShack p/n 276-195.

I originally conceived this device as an add-on for a kid's tricycle, so I wanted the sort of handlebar-mounted switch that is typical of a horn. I couldn't find one in a store, so I cobbled one from a RadioShack push button part number 275-646 and a cap from a soda bottle. I made a hole in the top of the cap large enough to pass the button, connected a couple of wires to it and ran these out a small hole in the side. I filled the bottom of the cap with auto body filler and stuck a hose clamp (from any hardware store) into this

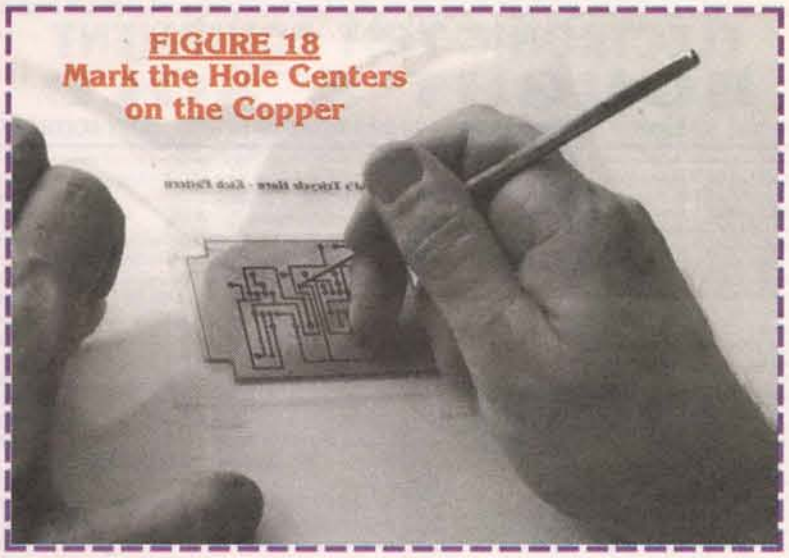


FIGURE 18
Mark the Hole Centers on the Copper

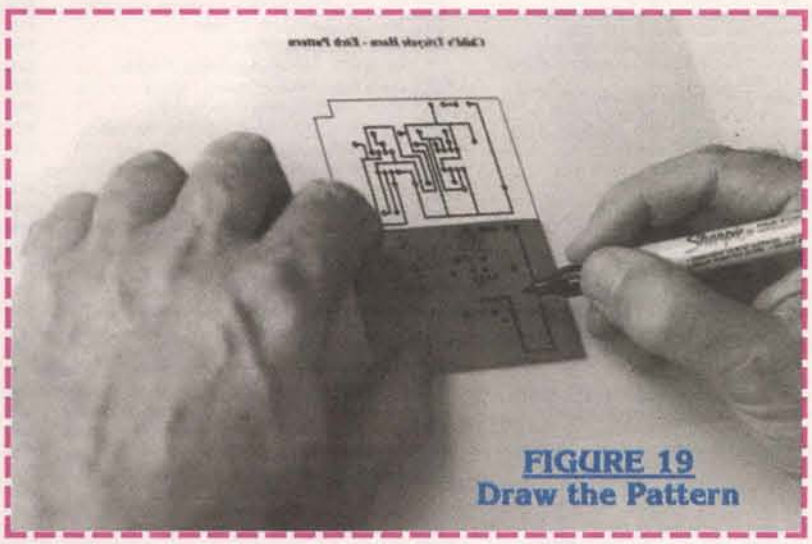


FIGURE 19
Draw the Pattern

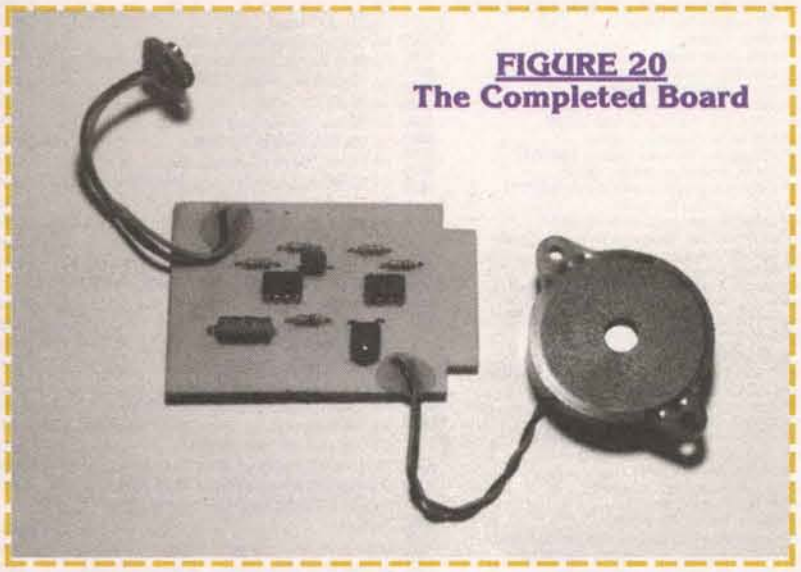


FIGURE 20
The Completed Board

material while it was drying. As you can see, it fits nicely. To be able to secure the box to a handlebar or other support, I cut a couple of slots in the cover of the case and threaded a larger hose clamp through them. Figure 22 shows the whole thing in place, and in use by a future road warrior.

I hope that you enjoy using these PowerPoint tools for your projects, and I welcome comments and suggestions at Stevedanls@AOL.COM. Completed copies of the schematic and/or PC board templates are available as PowerPoint 7.0 files. Send your E-Mail address with a check or money order for $10.00 for each template to: Small Bear Electronics, 123 Seventh Avenue, Suite 156, Brooklyn, NY 11215; or check out http://home.netcom.com/~smallbearelec. **NV**

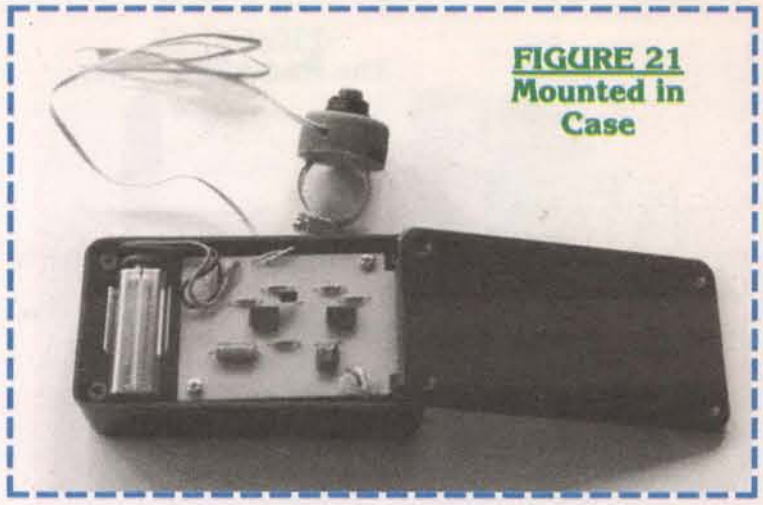


FIGURE 21
Mounted in Case

FIGURE 22
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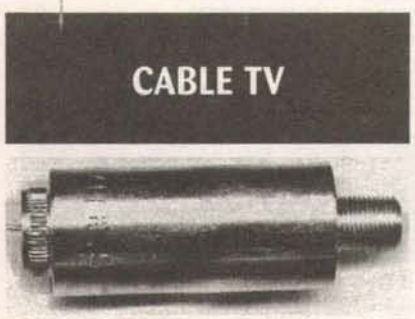

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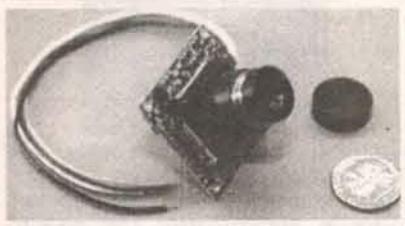

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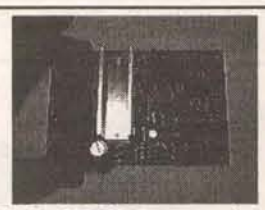

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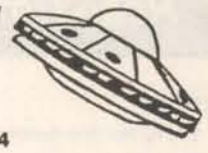

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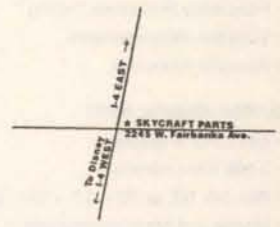

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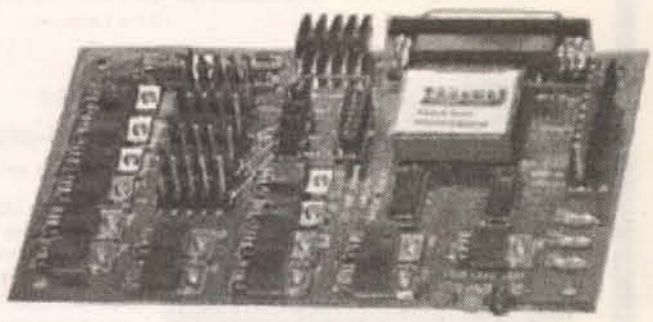

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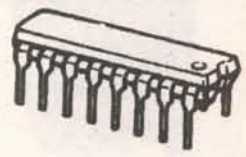

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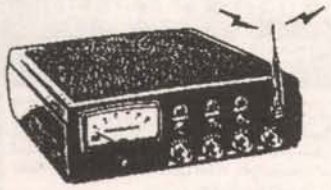

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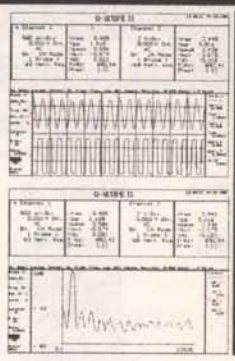

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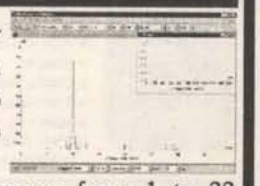

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Continued from page 22

presented quite a spectacle to the neighbors.

I have since admonished my son for "playing" with the tubes (especially on bicycles) after pointing out some of the hazards he had let himself in for on that little escapade. But I did promise him we would do some higher level experimentation.

After I described the Tesla coil to him he has asked me about little else. Then I saw your article in *Nuts & Volts*, and I thought "perfect timing," perfect for halloween! At this rate, who knows what he will be cooking up in the garage by the time he is 15!

Greg Hultman, via Internet

Dear Nuts & Volts:

I happened to see the Sept. '99 issue in Barns & Nobles — the cover instantly caught my eye. I love the article on the Tesla coil.

There were little bits of information in the article that I had not known. For example, the difference in connecting the grounds to the different coils.

I downloaded the software from the website at the end of the article, which was an added bonus. I like reading about exciting electronics stuff — Tesla coils, HV devices. I think I'm going to subscribe, thanks for a great, fun issue.

Joseph Gallo, via Internet

Dear Nuts & Volts:

Thanks for including the article on the Tesla coil. I would like to add a reminder that some neon sign transformers are internally grounded ... Beware of metal edges on tables, etc., in the area of the coil or Jacob's ladder when it is operating. They act as simple receivers and can provide a nasty shock, especially where the ends of the edge terminate. Sometimes, you can see a spark there as the edge resonates to the RF field. As an experiment, one could try to duplicate the work of Hertz with a simple loop receiver. It would be better to have such phenomena under "control" rather than as chance.

The Jacob's ladder can be made "hotter" by bridging the ladder with a high-voltage capacitor such as a Leyden jar. Unfortunately, this also causes the assembly to act as a spark gap transmitter with the wires of the ladder being the "aerial."

I have learned some of this from "the school of hard knocks." I have been extremely lucky ... There is really no reason for others to "reinvent the square wheel."

via Internet

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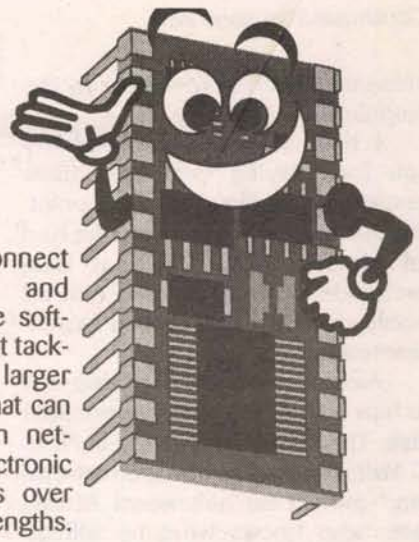
STAMP APPLICATIONS

by Lon Glazner

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips



A Multi-Drop Stamp-Based Network

There's been a lot of talk these last few years about the Internet and the creation of an information super-highway here in America. With all of the attention paid to the phenomena of the world wide web, I thought it was high time to bring the BASIC Stamp into this arena of networked electronics.

Overview

Think of STAMP Net as your very own information super-"dirt road." Okay, so it's not as cool or revolutionary as the Internet. You won't be able to exchange jokes with your co-workers when you're supposed to be slaving away for the boss. In fact, it'll be pretty slow and somewhat application specific. But for those of you who have considered automating your house with BASIC Stamps, or centralizing the control of some manufacturing equipment, STAMP Net should get you on your way.

The STAMP Net design consists of both the hardware communication architecture, as well as a software communication protocol required to connect a group of BASIC Stamp2 SXs (BS2-SX) together over an RS-485 network.

Defining the Design

We have a unique opportunity with this design. Typical engineering revolves around problem solving. Parts are selected, and software is written to solve a specific problem with time-to-develop and system cost being considered. STAMP Net is not such a design. Instead, it could be considered a design looking for an application. It could be used as a greenhouse monitoring system, a home lighting control network, or maybe as the backbone of a workshop alarm. We simply have to develop a multiple BS2-SX network, and a generic communication protocol, both of which should be flexible enough to fit a myriad of applications.

My choice for the hardware is the relatively simple RS-485 electrical specification (the actual specification is TIA/EIA-485-A). This specification allows multiple receivers and transmitters (commonly referred to as drivers) on the same communication bus. Our system will be half-duplex (only one device transmitting at a time), and will operate using a Master-Multiple Slave protocol (a single Master unit will initiate all communication to multiple Slaves on the RS-485 bus).

Notice that I stated previously that RS-485 was relatively simple. With short distances and low speeds, the industry standard RS-485 transceivers (both a transmitter and receiver) function well without much in the way of impedance matching or transmission line effects. For this article, the RS-485 network will be only a few inches in length so that we can concentrate on the communication protocol. Next month, we'll extend the number of BS2-SXs on the network and lengthen the cables, which may bring into play a host of gremlins.

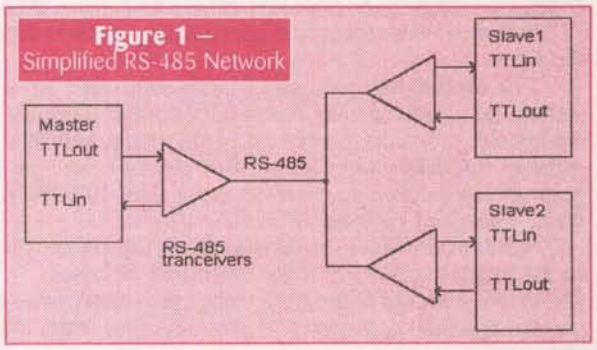
Figure 1 displays a very simplified RS-485 network in block diagram format. This is pretty much what we'll have hooked up at the end of this part of the design. Again, the main reason for this is so that we can connect the parts and write a little software without tackling the larger problems that can occur when networking electronic components over long cable lengths.

The Nuts and Bolts of RS-485

RS-485 is often called a "differential-pair" multidrop network. The "differential-pair" refers to the fact that the inputs to an RS-485 receiver consist of a pair of inputs (input A and input B), and the receiver is designed to respond to voltage differences between the two inputs. Using a differential pair for detecting voltage threshold changes can significantly reduce noise effects in a system like this. The multidrop moniker refers to multiple devices residing on the network.

RS-485 networks have been used across distances as great as 5,000 feet. The longer the distance your RS-485 network traverses, the greater your problems become with regards to noise, ground return losses, transmission line reflections,

Figure 1 – Simplified RS-485 Network



Byte	Number	Description
Address	1	Address of unit message is intended for
Program	2	Program to be executed by receiving unit
Data 1	3	General purpose data byte
Data 2	4	General purpose data byte
Data 3	5	General purpose data byte
Data 4	6	General purpose data byte
Data 5	7	General purpose data byte
Checksum	8	Sum of all bytes in message

Table 1: Command and Response String Definition

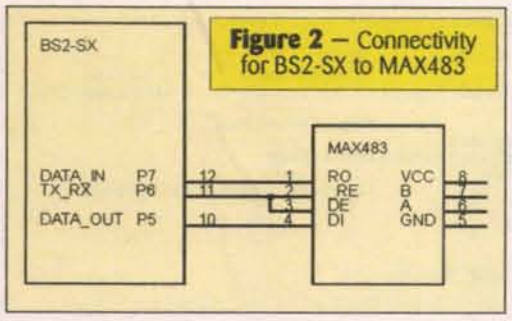


Figure 2 — Connectivity for BS2-SX to MAX483

and reduced data rates. At long distances this relatively simple network can become a significant engineering design. So try not to get too carried away with STAMP Net unless you've got some troubleshooting time on your hands.

RS-485 is an electrical specification and not a communication protocol. In other words, RS-485 is defined by how its receivers and transmitters interact electrically, and what voltage levels and current loads they can operate within. How data is sent on an RS-485 network is, to a large degree, left up to the network designer. Of course, data rates are limited by the hardware used in an RS-485 design, which may affect aspects of any communication protocol.

There are a large variety of RS-485 transceivers on the market. Some provide physical isolation for your communication system, others are lower cost, very simple transceivers. I'm partial to the use of MAXIM Integrated Products, Inc., parts. They have a solid sample policy, which can be beneficial for some of the penny-pinching hobbyists out in Stamp land. I've also had success with their parts in the past. For these reasons, I'm selecting the low-cost MAX483 RS-485 low power transceiver for this design.

The MAX483 does not provide electrical isolation for this RS-485 network. Therefore, all circuit grounds are common, and should be connected via a conductive ground wire that runs the length of the network with the communication pair (A and B inputs/outputs). On the BS2-SX side, the MAX483 is interfaced via three wires. The first two are the receiver output (RO) which sends data to the BS2-SX from the RS-485 network and the data input (DI) which receives data from the BS2-SX and places it on the RS-485 network bus. The last connection is the receiver enable (asserted with a logic low) and driver enable (asserted with logic high) pins which can be tied together and connected to a single BS2-SX output. This last connection allows the BS2-SX to select the state of the RS-485 transceiver. Figure 2 is representative of this connectivity.

In STAMP Net, the Master unit will generally place its MAX483 in driver mode (TX_RX high), while all of the Slaves will remain in receive mode (TX_RX low), unless a command from the Master requires a response from one of the Slaves.

What's a Communication Protocol?

In today's world of high-speed telecommunication and cellular technology, I feel pretty silly describing what a communication protocol is. But I constantly hear engineers referring to electrical specifications as communication protocols. For instance, I've often heard the term RS-232 (which denotes voltage levels, as well as driver and receiver specifications in the same manner as RS-485) used to describe serial communication. When in actuality it only describes the

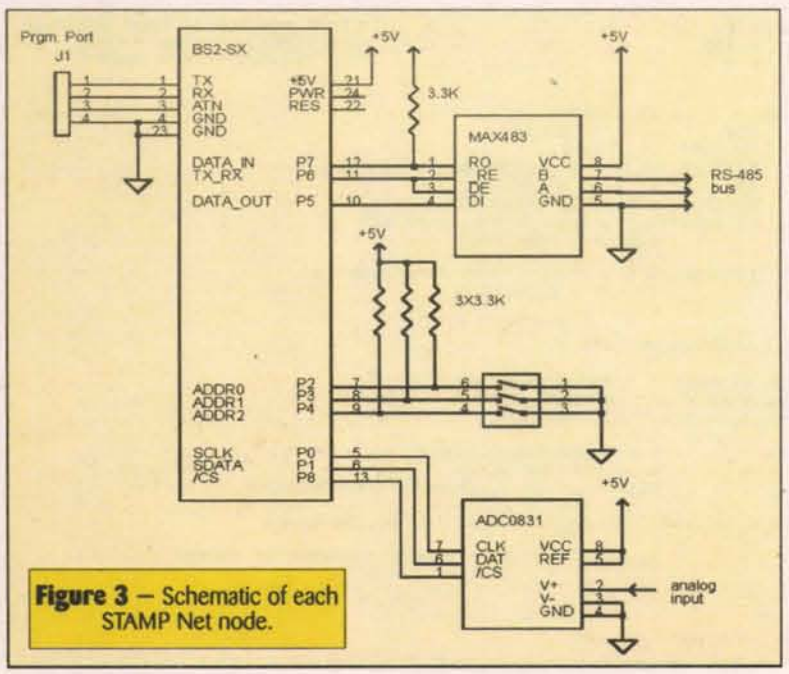


Figure 3 — Schematic of each STAMP Net node.

```
'*****************************************************************
'Master Program
'The Master program controls communication and data display. For a
'unit designated as a Master unit (addresss = 0) this program is
'used to poll the various slave units. If a unit is a Slave unit
'(address <> 0) then this program is where the unit waits for
'commands.
'
'{$STAMP BS2SX,C:\Parallax\Analog.bsx}
'0:Master_Prgm.bsx

'I/O pin designations
AD_Clk    CON       0                       'ADC0831 clock pin
AD_Dat    CON       1                       'ADC0831 data pin
AD_CS     CON       8                       'ADC0831 chip select(asserted low)

'Communication Constants
Data_Out CON        5                       'TTL data out pin
TX_RX     CON       6                       'Receive enable(asserted low)
Data_In  CON        7                       'TTL data in pin
Baud      CON       45                      '38.4kbps, 8N1 true data

'Internally used registers
Addr              var       byte            'Address of unit
Comm_Flag         var       byte            'flag bits for unit
        Mstr      var       Comm_Flag.bit0  'Set for Master unit cleared for Slave
        S1        var       Comm_Flag.bit1  'Set if Slave # 1 is present on RS-485 bus
        S2        var       Comm_Flag.bit2  'Set if Slave # 2 is present on RS-485 bus
        S3        var       Comm_Flag.bit3  'Set if Slave # 3 is present on RS-485 bus
        S4        var       Comm_Flag.bit4  'Set if Slave # 4 is present on RS-485 bus
        S5        var       Comm_Flag.bit5  'Set if Slave # 5 is present on RS-485 bus
        S6        var       Comm_Flag.bit6  'Set if Slave # 6 is present on RS-485 bus
        S7        var       Comm_Flag.bit7  'Set if Slave # 7 is present on RS-485 bus

'Communication message string variables bytes(8 total)
Addr_Req var      byte                      'Unit address of message destination
Prgm_Req var      byte                      'Request execution of this program
Dat1              var       byte            'Data byte 1
Dat2              var       byte            'Data byte 2
Dat3              var       byte            'Data byte 3
Dat4              var       byte            'Data byte 4
Dat5              var       byte            'Data byte 5
Checksum var      byte                      'Sum of previous bytes

'Storage Registers
Put_Addr          var       byte            'Put address location

Get_Addr          var       byte            'Get address location
'Working registers
Loop1             var       byte            'For...Next variable
Work1             var       byte            'General purpose register
Work2             var       byte            'General purpose register
Work3             var       byte            'General purpose register
Work4             var       byte            'General purpose register
WorkBig           var       word            'Word sized general purpose register


'A/D registers
ResultA_D         var       byte            'Result of A to D measurement
MaxA_D            var       byte            'Storage for maximum A to D result
MinA_D            var       byte            'Storage for minimum A to D result
AvgA_D            var       byte            'Storage for avg. A to D result

'*****************************************************************
Main_Program:

Outs              = %0000000100100000       'Set output pin values
Dirs              = %0000000101100011       'Set pin direction values

Get_Address:
Comm_Flag         = %00000000
Addr      = (INL&%0011100)/4                'Get unit address from P4-2
If Addr <> 0 then No_Master
        Mstr = 1
No_Master:
Pause             2000

'Addr and Comm Flag register Debug statements
'Debug   "Address = ", BIN8 Addr,CR
'Debug   "Comm Flag = ", BIN8 Comm_Flag,CR
'Pause   1000

If Mstr = 1 then Master_Program
        Goto      Slave_Program

'*****************************************************************
Master_Program:

For Addr_Req = 1 to 7
        Pause             1000
        Prgm_Req = 1
        Checksum          = Addr_Req+Prgm_Req+Dat1+Dat2+Dat3+Dat4+Dat5
        HIGH              Data_Out          'Set output high
        HIGH              TX_RX             'Enable transmission on RS-485
        SEROUT            Data_Out,Baud,[Addr_Req,Prgm_Req,Dat1,Dat2,Dat3,Dat4,
Dat5,Checksum]
        PAUSE             1
        LOW               TX_RX             'Enable receiver on RS-485
        SERIN             Data_In,Baud,500,No_Data,[Work1,Work2,Dat1,Dat2,Dat3,Dat4,
Dat5,Checksum]
                                            'Test checksum
        Work4     = Work1+Work2+Dat1+Dat2+Dat3+Dat4+Dat5
        If Work4 <> Checksum Then Bad_Data
                                             'Set flag for unit that responds
        Work3 = %00000001                    'Set up pointer bit
        Work3 = Work3 << Addr_Req            'Rotate "1" into Slave location
        Comm_Flag         = Comm_Flag+Work3   'Add pointer bit to designate active
Slave
                                            'Display incoming data
        Debug "Address of Sender = ",DEC Addr_Req,CR
        Debug "Data byte 1   = ",DEC Dat1,CR
        Debug "Data byte 2   = ",DEC Dat2,CR
        Debug "Data byte 3   = ",DEC Dat3,CR
        Debug "Data byte 4   = ",DEC Dat4,CR
        Debug "Data byte 5   = ",DEC Dat5,CR
Send_Next_Addr:
        Next
        Goto      Done_Polling
Bad_Data:
        Debug     "Checksum Invalid Addr: ",DEC Addr_Req,cr
        Goto      Send_Next_Addr
No_Data:
        Debug     "No Data Returned Addr: ",DEC Addr_Req,cr
        Goto      Send_Next_Addr
Done_Polling:
        Debug     "Comm_Flag = ", BIN8 Comm_Flag,CR
        Pause     3000
        Goto      Get_Address
```

electrical requirements of a specific communication network or bus.

A communication protocol describes the manner in which data is exchanged. The electrical specification or drivers used to connect the data generators may be part of the protocol, but they do not define it. There are certain hardware and timing issues, as well as software issues that define a communication protocol.

From a hardware standpoint, we can describe STAMP Net as an RS-485 based multi-drop network. This will be a Master-Slave system with no more than one Master and no more than seven Slaves (this number could be greatly expanded, but we'll keep it small for now). Communication will be serial in nature, and will meet the format of eight data bits, no parity, and one stop bit, with true polarity (8N1, with the start-bit defined by a logic "0" at the BS2-SX input). The data rate will be fixed at 38.4kbps. We'll be making use of the SERIN and SEROUT commands to perform the byte-by-byte transmission and reception of data.

The Master-Slave configuration is by far the easiest to implement. In this configuration, only a Master unit can initiate communication. In order for each Slave to report its current status, the Master would have to "poll" each existing unit. In a large network, this can prevent the Master-Slave concept from working. It would also be inappropriate to use a Master-Slave system if your Slave units are reporting time-critical information, such as failure conditions. But for something like a greenhouse monitor or a smaller network such as the one being designed here, the Master-Slave concept works well.

No communication protocol would be complete without a discussion of message types. Again, we're going to take the easy road, and limit the number of message types in our system to two. They will be the Master initiated Command and the Slave return of the Response. Each message will consist of eight bytes.

The software for the Master and Slave units will be identical in this design. In fact, the only difference between the Master and Slave units will be the address of the units. A unit with an address of "0" will default to the Master unit. Any other address (1 through 7) will default to a Slave. A Slave will always wait for communication and send its Response string to address "0." The Master, on the other hand, will poll units 1 through 7, and display their responses.

Next month, we'll add a little more functionality and a PC interface for the Master unit.

The Hardware

Since our Master and Slave units are going to be identical in software, we may as well make them identical in hardware. The addressing will be set with a three-position DIP switch. The RS-485 transceiver will be interfaced to as described by Figure 2, which will require an additional three I/O lines. Finally, I'm going to add an eight-bit analog-to-digital (A/D) converter, with a serial-peripheral-interface (SPI) which will require three more I/O lines. A schematic of this configuration is displayed in Figure 3.

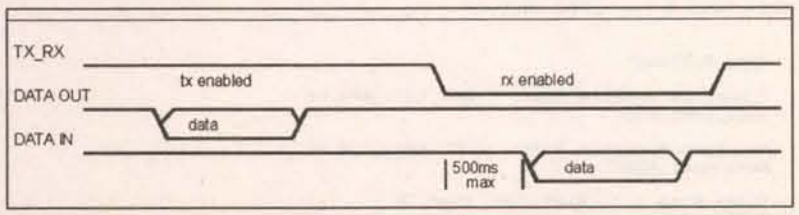


Figure 4 – Software Response Timing Requirement

```
'*****************************************************************
Slave_Program:
        Debug   "Slave Program ",CR
        LOW     TX_RX                           'Enable receiver on RS-485
        SERIN   Data_In,Baud,[Addr_Req,Prgm_Req,Dat1,Dat2,Dat3,Dat4,Dat5,Checksum]
                                                'Test checksum
        If Addr_Req <> Addr Then Bad_Address
        Work4   = Addr_Req+Prgm_Req+Dat1+Dat2+Dat3+Dat4+Dat5
        If Work4 <> Checksum Then Bad_Sum
        RUN     Prgm_Req                        'Execute requested program
Bad_Sum:
        Debug   "Checksum Invalid: ",cr
        Goto    Slave_Program
Bad_Address:
        Debug   "Wrong Address: ",DEC Addr_Req,cr
        Goto    Slave_Program
END
```

Code Listing 1: Master_Prgm.bsx

```
'Analog.bsx
'This is program 1 for the STAMP Net design. If this program
'is requested then 128 analog measurements are taken with the
'ADC0831 analog to digital converter. The maximum, minimum,
'and average result are returned to the Master unit.

'I/O pin designations
AD_Clk          CON     0               'ADC0831 clock pin
AD_Dat          CON     1               'ADC0831 data pin
AD_CS           CON     8               'ADC0831 chip select(asserted low)
AD_Samples      CON     128             'Number of samples taken

'Communication Constants
Data_Out        CON     5               'TTL data out pin
TX_RX           CON     6               'Receive enable(asserted low)
Data_In         CON     7               'TTL data in pin
Baud            CON     45              '38.4kbps, 8N1 true data

'Internally used registers
Addr            var     byte            'Address of unit
Comm_Flag       var     byte            'flag bits for unit
        Mstr    var     Comm_Flag.bit0  'Set for Master unit cleared for Slave
        S1      var     Comm_Flag.bit1  'Set if Slave # 1 is present on RS-485 bus
        S2      var     Comm_Flag.bit2  'Set if Slave # 2 is present on RS-485 bus
        S3      var     Comm_Flag.bit3  'Set if Slave # 3 is present on RS-485 bus
        S4      var     Comm_Flag.bit4  'Set if Slave # 4 is present on RS-485 bus
        S5      var     Comm_Flag.bit5  'Set if Slave # 5 is present on RS-485 bus
        S6      var     Comm_Flag.bit6  'Set if Slave # 6 is present on RS-485 bus
        S7      var     Comm_Flag.bit7  'Set if Slave # 7 is present on RS-485 bus

'Communication message string variables bytes(8 total)
Addr_Req var    byte                    'Unit address of message destination
Prgm_Req var    byte                    'Request execution of this program
Dat1            var     byte            'Data byte 1
Dat2            var     byte            'Data byte 2
Dat3            var     byte            'Data byte 3
Dat4            var     byte            'Data byte 4
Dat5            var     byte            'Data byte 5
Checksum var    byte                    'Sum of previous bytes

'Storage Registers
Put_Addr var    byte                    'Put address location

Get_Addr var    byte                    'Get address location

'Working registers
Loop1           var     byte            'For...Next variable
Work1           var     byte            'General purpose register
Work2           var     byte            'General purpose register
Work3           var     byte            'General purpose register
Work4           var     byte            'General purpose register
WorkBig         var     word            'Word sized general purpose register

'A/D registers
ResultA_D       var     byte            'Result of A to D measurement
MaxA_D          var     byte            'Storage for maximum A to D result
MinA_D          var     byte            'Storage for minimum A to D result
AvgA_D          var     byte            'Storage for avg. A to D result
Num_Meas var    byte                    'Storage for number of samples taken

'*****************************************************************
Main_Program:

Comm_Flag       = %00000000
Outs            = %0000000100100000             'Set output pin values
Dirs            = %0000000101100011             'Set pin direction values

Get_Address:
Addr    = (INL&%0011100)/4                      'Get unit address from P4-2

        WorkBig = 0                             'Clear average storage register
        MinA_D  = 255                           'Set minimum to max output
        MaxA_D  = 0                             'Set maximum to min output

Measure_Analog:
        For Loop1 = 1 to AD_Samples
                LOW             AD_CS
                PULSOUT AD_Clk,10
                SHIFTIN AD_Dat,AD_Clk,msbpost,[ResultA_D]
                HIGH            AD_CS
                WorkBig = Workbig + ResultA_D
                If ResultA_D < MaxA_D Then Test_Min
                        MaxA_D = ResultA_D
Test_Min:
                If ResultA_D > MinA_D Then Keep_Sampling
                        MinA_D = ResultA_D
Keep_Sampling:
        Next
        AvgA_D = WorkBig/AD_Samples

'Debug  "Average Storage = ",DEC WorkBig,cr
'Debug  "Minimum A to D = ",DEC MinA_D,cr
'Debug  "Maximum A to D = ",DEC MaxA_D,cr

        Checksum        = MaxA_D+MinA_D+AvgA_D
        HIGH            Data_Out 'Set output high
        HIGH            TX_RX           'Enable transmission on RS-485
        SEROUT
Data_Out,Baud,[$00,$00,MaxA_D,MinA_D,AvgA_D,$00,$00,Checksum]
        PAUSE           1
        LOW             TX_RX           'Enable receiver on RS-485

        RUN     0                       'Return to main program
END
```

Code Listing 2: Analog.bsx

The Software

The software here is broken down into two main programs. These programs are basically the starting points for developing a versatile Stamp-to-Stamp communication interface.

The main program (Master_Prgm.bsx) begins by determining the address of the unit. If its address is a "0," then the Stamp defaults to a Master and begins polling for other units on the network. Any responses are displayed via a Debug command for this program. Additionally, the communication flag register (Comm_Flag) stores bits, which indicate which STAMP Net nodes are responding. This flag register would be an easy-to-use status register indicating any units that may be having communication problems on your network.

For Slaves, Master_Prgm.bsx is used to wait for commands from the Master unit. When a command is received, it is tested for a matching address and for a correct checksum. The address requirement is necessary for any BS2-SX to ignore commands to other BS2-SXs on the network. The checksum requirement allows BS2-SX slaves to ignore any corrupted data that they may be receiving. A Slave will always respond with a "0" for both the Address and Program bytes of a response string (see Table 1).

Notice that by selecting a set number of bytes for all commands and responses, I have made it easier to distinguish between commands from a Master and responses from other Slaves. And both can be processed and discarded, if need be, by the same software routine.

The second program (Analog.bsx) is the first of a set of network functional programs. This program interfaces to an ADC0831 eight-bit analog-to-digital converter; 128 samples are taken when this program is executed, and the maximum, minimum, and average measurements are returned via the RS-485 bus. This program is also responsible for responding to the Master unit.

Some communication protocol timing issues must be addressed by both pieces of software. You need to make sure that no two Stamps on the network are ever trying to transmit at the same time. For Analog.bsx, this is not a great concern. It takes long enough for the Slave BS2-SX to take all of its measurements (128 total) that the Master will be in receive mode prior to any data being sent out of the Slave executing Analog.bsx.

The time allowed for a Slave to respond to a Master unit's command is 500ms. This timing is excessive and could be reduced based on the time required for the commands issued to be processed. But this early in the game, I decided to place no major time constraints on the Master-Slave interface. A diagram of what you would see at the interface between a Master unit and the MAX483 is displayed in Figure 4.

In Closing

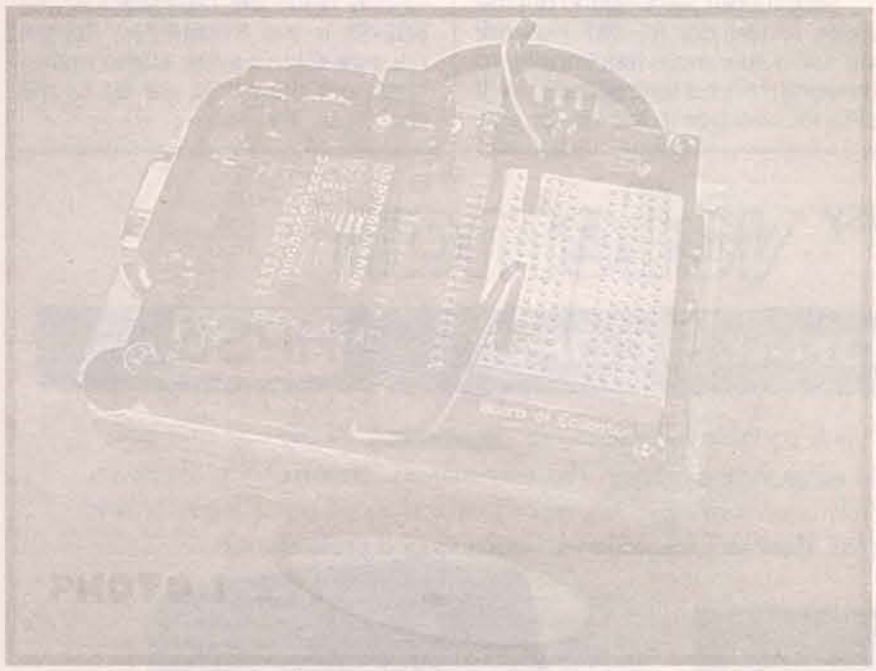
The STAMP Net design is by no means complete. The RS-485 interface must be tested over actual cables, and more program functions need to be added to the interface. But you can start to see the bare bones of a BS2-SX network beginning to take shape.

Next month, we'll extend out the cables to test our RS-485 network and add a little more functionality to the design. And, if time permits, we'll add a PC interface to the Master side of the software.

I can already tell that the additional program memory available in the BS2-SX will lend itself to a much more complex system than would be possible with the sturdy BASIC Stamp 2. And while it's unlikely that I'll fully utilize the capabilities of the BS2-SX in the STAMP Net design, I'm sure there's a few Stamp enthusiasts out there that are up to the challenge. **NV**

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel



Last month, I presented PIC assembly code for a crude software-only I2C master. The code was to generate SDA and SCL waveforms that comply with the I2C specification for the purpose of developing and testing a software-only slave. Along the way, I showed how to use the START/STOP detector circuit (Sept. '99) for triggering a 'scope to get a stable display of the I2C waveforms.

The code sure wasn't pretty, but it worked – mostly. In fact, the master code presented was brain-dead in a number of ways: It didn't pay attention to ACK pulses, bit arbitration, or clock stretching, and it assumed it alone controlled the I2C bus. Some stub functionality of clock stretching and bit arbitration were there, but commented out for later testing. Nevertheless, it did give me a simple, easily-modified I2C signal generator, which was all I really needed to get going on this iterative design process.

This time, I'll look at bit-level routines for an I2C slave. I'll also do mini reviews for two new robot kits, and say a few words about the loneliness of the Long-Distance Robot Builder.

Tweak the Master

Only minimal modifications need to be made to the code from last month for it to play nice with a slave. I'll just show the segment that contains most of the changes (Listing 1), and outline what changes I made elsewhere. If anyone needs to get their hands on the full code, drop me a line.

Last time, the master simulated writing to I2C address 01110000. Combined with the write bit, the first byte transmitted after START was 01110000. The next byte was arbitrarily chosen to be 10110101.

Okay, the master must allow the slave to place data on SDA at the appropriate times. I wanted to test both reading and writing data to a slave; the address field works fine as a write, and the read can be the next byte in the datagram.

The I2C bus uses open-drain mode, so any time a one is output, it's the same as putting the line in a high-impedance state. Because of this, all the master has to do to allow the slave to place data on the bus is to send a second byte of all ones. The master still believes it is in sole control of SDA, but this change forces it to get out of the way so the slave can transmit data.

Notice in Listing 1 that I also changed the R/W bit to be a one instead of a zero. This reflects that this is to be a read operation. Thus, the whole datagram sent by the master is: S01110001A11111111AP, (where S, A, and P represent START, ACK, and STOP).

Since the master ignores everything the slave does, the value of R/W doesn't make any difference. Indeed, the slave code ignores R/W. I changed it all the same to make the datagram consistent with the I2C spec. During early testing, though, my choice had an interesting consequence (more on that later).

Listing 1

```
; ** Test datagram write
;       entry:
;       exit:

test
        call    i2c_init
test2:
        call    i2c_wait        ; Wait for bus free condition
        call    start           ; Create START condition
        movlw   0x71            ; Set to read from addr 0111000b
        movwf   i2c_out
        call    put_byte        ; Send the address + R/W flag
        call    get_ack
        movlw   0xFF            ; Set up data 11111111b
                                ; This is to test slave
        movwf   i2c_out
        call    put_byte        ; Send data
        call    get_ack
        call    stop            ; Create STOP condition
        goto    test2           ; repeat forever
```


The other changes I made to the master code were mainly cosmetic, a matter of changing labels and cleaning up the constants used for accessing SCL and SDA. The equates and #defines in the slave code (Listing 2) show the nature of what I did. All writes to TRISA are now indicated by use of W_SDA or W_SCL, and all reads from PORTA are indicated by R_SDA and R_SCL. I did these things to make the master and slave code a bit easier to read.

A Software-only I2C Slave

As I mentioned last time, the hard part of building an I2C slave in software isn't getting the slave to poll the bus lines often enough that START can be reliably detected; it's leaving enough processing cycles free for the slave to do other work besides monitoring the I2C bus. My current slave code does detect START reliably, but it doesn't even try to do any other work. I have some ideas how to fix this, though, and I'll talk about them later. Let's take a look first at the core routines of the slave.

When the bus is idle, the slave waits for a START condition in the idle routine. This short routine detects START in three to six cycles. Once START is detected, the slave must then wait for SCL to go low for the first bit and, once that happens, the slave can start reading bits in from SDA.

In the interest of speed and readability, reading and writing bits are handled by inline macros. The macro rcv_bit takes as its parameter the bit number of the current byte being received and sets or clears the corresponding bit in the variable i2c_in. Likewise, the macro xmt_bit sets or clears the SDA line according to the state of the bit in i2c_out selected by the macro's bit number parameter. Both macros are invoked eight times; once each for bits 7 through 0 of the byte being sent or received.

"rcv_bit" first releases SCL (in case it was being stretched by the slave), then enters a loop that samples SDA and checks if SCL has gone high. Once SCL rises, the sampled bit goes into the input buffer, and "rcv_bit" waits in a second loop for SCL to go low. This loop is three cycles, for a maximum 1.2 usec lag in recognizing the falling edge of SCL.

Finally, "rcv_bit" outputs a low on SCL to stretch the clock as long as the receiver needs. Since the first thing "rcv_bit" does is to release SCL, and since the overall loop is short enough, this causes no trouble even with a master that doesn't recognize clock stretching.

"xmt_bit" is simpler. It first releases SCL, outputs the SDA level,

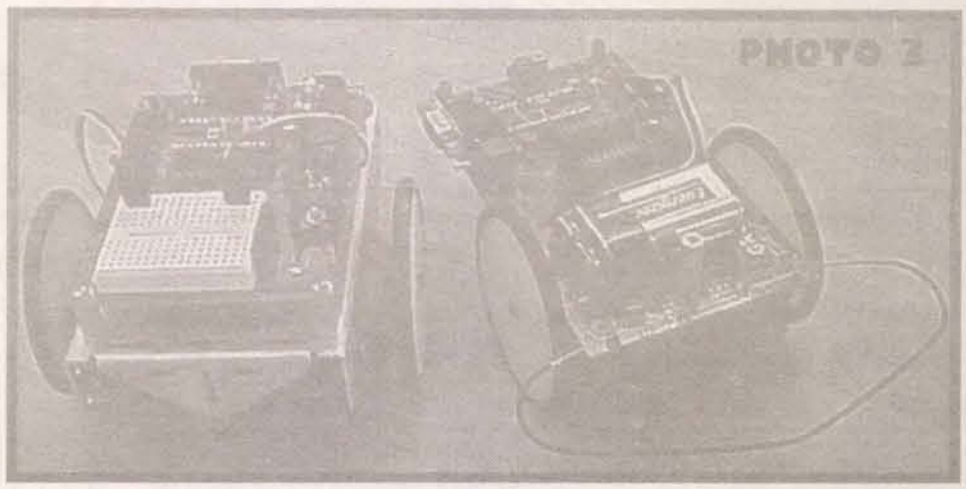


PHOTO 2

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

Robert Nansel
69 S. Fremont Ave. #2
Pittsburgh, PA 15202
E-Mail:
bnansel@nauticom.net

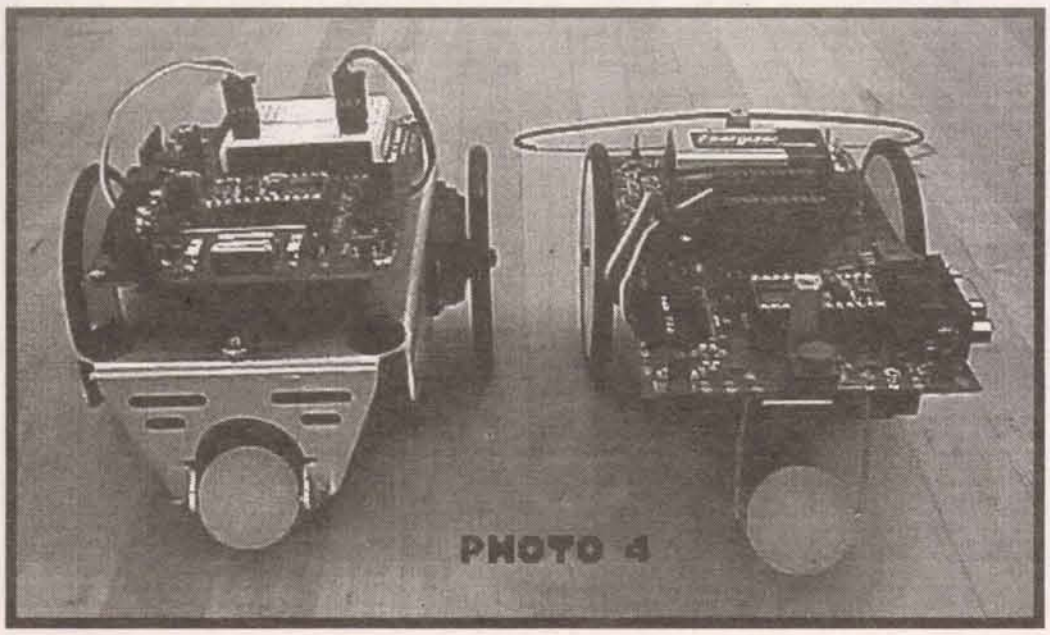


PHOTO 4

Listing 2

```
title "slavetst.asm"

; slavetst.asm   -  Respond to I2C Master test data pattern
;          (c) 1999 by Robert Nansel
; This program is free software; you can redistribute it and/or
; modify it under the terms of the GNU General Public License as
; published by the Free Software Foundation. Details of the GNU
; GPL can be found at www.fsf.org or by writing to the Free
; Software Foundation, Inc., 59 Temple Place, Suite 330, Boston,
; MA  02111-1307, USA.
; It comes with ABSOLUTELY NO WARRANTY, implied or otherwise.
;
; Revision history:v0.01.0 - 9/29/99
;                          - basic bit-level slave routines

      LIST P=16F84, F=INHX8M, R=DEC    ;  16F84 Runs at 10 MHz
      errorlevel 0,-305
      INCLUDE "\progra~1\mplab\p16F84.inc"

; ** Registers

 __CONFIG _CP_OFF & _WDT_OFF & _HS_OSC & _PWRTE_ON


; ** Constants

i2c_clr          equ     0xFC
i2c_set          equ     0x03
idle_out  equ    0x03
start_outequ     0x01

ack              equ     0x00
no_ack           equ     0xFF

SCL              equ     0       ; Ser. Clock, bit 0 PortA
SDA              equ     1       ; Ser. Data, bit 1 PortA
SDA_mask         equ     0x02

#define R_SCL   TRISA, SCL      ; Read SCL, bit 0 PortA
#define R_SDA   TRISA, SDA      ; Read SDA, bit 0 PortA
#define W_SCL   PORTA, SCL      ; Write SCL, bit 0 PortA
#define W_SDA   PORTA, SDA      ; Write SDA, bit 1 PortA



; ** Delay values
;
; (these will eventually be used when invoking the delay macro)
;
F_Osc            equ     10                      ; 10 MHz XTAL
T_cyc            equ     10000/((F_Osc*10)/4)    ; T_cyc ns/cycle
T_buf            equ     ((47000/T_cyc)+5)/10    ; 4700 ns
T_hdsta          equ     ((40000/T_cyc)+5)/10    ; 4000 ns
T_low            equ     ((47000/T_cyc)+5)/10    ; 4700 ns
T_high           equ     ((40000/T_cyc)+5)/10    ; 4000 ns
T_susto          equ     ((40000/T_cyc)+5)/10    ; 4000 ns


; RAM Usage

        CBLOCK 0x00C
_w              ; ISR context storage
_status
bit_count       ; bit shift counter
i2c_out         ; output buffer
i2c_in          ; input buffer
temp            ; temporary storage
        ENDC


; Macro definitions

; ** Receive bit from i2c master
;
;       This is a modified version of the macro published 11/9/97
;       on the PICList by Marc Heuler <marc@aargh.mayn.de>. Marc's
;       macro was intended for a 4-MHz PIC, but I'm using it at 10 MHz.
;       I've altered variable names & some of the comments and added
;       SCL clock stretching capability. I've also corrected Marc's
;       macro usage to reflect the proper bit reception order (i.e.,
;       MSB first).

rcv_bit MACRO   BITNUM          ; read SDA bit into W.0 during T_high
        bsf     W_SCL           ; Stop stretching SCL
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        rrf     PORTA, w        ; wait for & read next bit
                                ;  W.0 = SDA, C = SCL
        btfss   STATUS, C       ; SCL was high when sampling?
        goto    $-2             ;
        andlw   1               ; isolate SDA in W.0
        btfsc   R_SCL           ;
        goto    $-1
        btfss   STATUS, Z       ; store SDA in proper bit
        bsf     i2c_in, BITNUM
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     W_SCL           ; Start stretching SCL

;>>* Insert enable, disable interrupt sequence here?

        ENDM


; ** Transmit bit to i2c master
;

xmt_bit MACRO   BITNUM
        btfss   i2c_out, BITNUM ; Send the bit
        bcf     W_SDA
        bsf     W_SCL           ; Stop stretching SCL
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        btfss   R_SCL           ; Wait for SCL to go high
        goto    $-1
        btfsc   R_SCL           ; Now wait for SCL to drop
        goto    $-1
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     W_SCL           ; Start stretching SCL

;>>* Insert enable, disable interrupt sequence here?

        bsf     W_SDA           ; Clean up
        ENDM


        PAGE

        org 0

i2c_init
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        movlw   i2c_set         ; Set up PA0, PA1 as inputs
        andwf   TRISA           ;
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        movlw   i2c_clr         ; Set up active low zeros
        andwf   PORTA           ; in PORTA

stop_rcvd
        clrf    i2c_in
        clrf    i2c_out

i2c_wait
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        movf    TRISA           ; Get I2C bits
        andlw   i2c_clr         ;
        iorlw   idle_out        ; SCL=1, SDA=1
        movwf   TRISA           ; Output bus pin values
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        nop                     ; Let bus settle 1.2 usec to
                                ;  meet I2C 1 usec max rise time
wait2   movlw   idle_out        ; SCL=1, SDA=1
        xorwf   PORTA, w        ; Check bus state
        andlw   i2c_set         ;
        btfss   STATUS, Z       ; I2C bus idle?
        goto    wait2           ; No, go wait for bus idle
        movlw   idle_out        ; Yes, continue
        xorwf   PORTA, w        ; Check I2C bus state 2nd time
        andlw   i2c_set         ;
        btfss   STATUS, Z       ; Bus still idle?
        goto    wait2           ; No, go wait for bus idle
        movlw   idle_out        ; Yes, continue
        xorwf   PORTA, w        ; Check I2C bus state 3rd time
        andlw   i2c_set         ;
        btfss   STATUS, Z       ; Bus still idle?
        goto    wait2           ; No, go wait for bus idle

idle    btfss   R_SDA           ; detects start condition when it lasts
        goto    start_rcvd      ; for at least 4 cycles
        btfss   R_SCL
        goto    wait2
        btfsc   R_SDA
        goto    idle

start_rcvd                      ; start cond. occurred <=5 cycles ago
        btfsc   R_SCL           ; wait for bit 0
        goto    $-1             ; clk must be low at least 3 cycles

        rcv_bit 7
        rcv_bit 6
        rcv_bit 5
        rcv_bit 4
        rcv_bit 3
        rcv_bit 2
        rcv_bit 1
        rcv_bit 0
```

then waits for SCL to cycle high, then low. It then pulls SCL low and releases SDA on exit. Releasing SDA allows the master to perform an ACK during a read cycle. This could be removed from the macro if more speed is desired, but an explicit release would need to follow the last invocation of the "xmt_bit" macro to ensure the SDA line is high for the ACK bit.

In both macros, notice the comment at the end about enabling and disabling interrupts. This is the wedge that will allow the slave to do work other than scanning the I2C bus. By combining clock stretching and interrupts, I believe a software-only slave can do useful work while processing an I2C datagram.

It would go something like this: Every time the slave detects that SCL has gone low, it can stretch out the SCL low time. While the slave pulls its SCL line low, it can safely enable interrupts. If the slave then gets an interrupt, or if there had been an interrupt pending, SCL will stay low while the slave services the interrupt.

On entry into the next invocation of the macro, the slave would disable interrupts immediately before releasing SCL. The master goes into a wait state as long as the slave holds SCL low, so no data would be lost.

The only places where this scheme would fail are when the slave is waiting for bus idle or when polling for a START condition. I'll show what can be done in these areas next time.

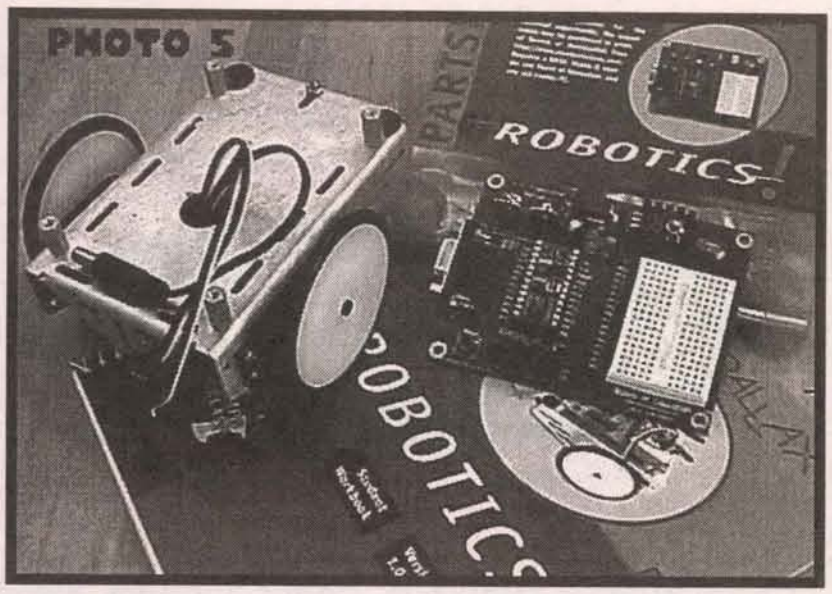
Testing the Slave

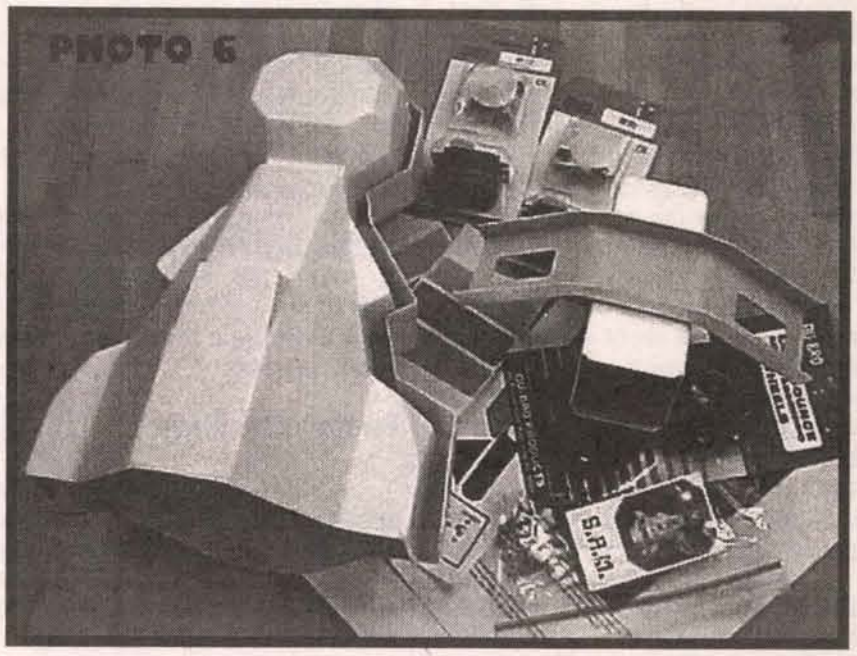
To test both read and write functionality, I simply have the slave read the address from the master then echo it back as data. If the slave receives the address properly, the first byte should equal the second.

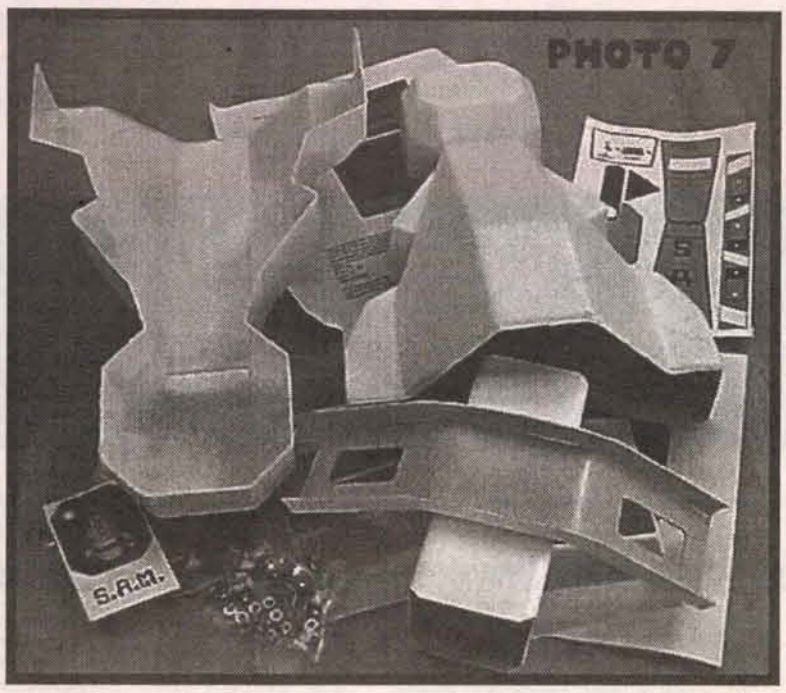
The first time I tried my slave code, everything seemed to be working except the data the slave echoed appeared to be backwards, with bit 0 first and bit 7 last. I pored over this

```
ack_address
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     W_SDA           ; Send ACK bit
        bsf     W_SCL           ; Stop stretching SCL
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        btfss   R_SCL           ; Wait for SCL to go high
        goto    $-1
        btfsc   R_SCL           ; Now wait for SCL to drop
        goto    $-1
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     W_SCL           ; Start stretching SCL

;>>* Insert enable, disable interrupt sequence here?

        bsf     W_SDA           ; Clean up

; ** Echo address received to test master/slave interaction

        movf    i2c_in, w       ; get value received...
        movwf   i2c_out         ; ...and echo it back

        xmt_bit 7
        xmt_bit 6
        xmt_bit 5
        xmt_bit 4
        xmt_bit 3
        xmt_bit 2
        xmt_bit 1
        xmt_bit 0

;>>* Get ACK pulse from master - (ignores ACK/NACK status for testing)
;
get_master_ack
        bsf     W_SCL           ; Stop stretching SCL
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        btfss   R_SCL           ; Wait for SCL to go high
        goto    $-1
        btfsc   R_SCL           ; Now wait for SCL to drop
        goto    $-1
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        bcf     W_SCL           ; Start stretching SCL

;>>* Insert enable, disable interrupt sequence here?

        bsf     W_SDA           ; Clean up


wait_stop
        bcf     STATUS, RP0     ;  (Ports in Bank0)
        btfss   R_SCL           ; Wait for SCL to go high
        goto    $-1
        btfss   R_SDA           ; Wait for SDA to go high
        goto    $-1
        bsf     STATUS, RP0     ;  (Tris in Bank1)
        goto    stop_rcvd

        end
```

Listing 2
continued







bug for about an hour, added a snippet of code to write the data the slave received to Port B to check that it was indeed backwards.

The more observant among you may already have figured out what the problem was. The address + R/W bit came out of the master as 01110001 — I could see it on my 'scope! No matter what I did, though, the slave always echoed it as 10001110, which does indeed look as if the bits were being reversed. But 10001110 is also the one's complement of the first byte, and this is where my decision to make the master output the "correct" value for the R/W bit came back to bite me. If I'd left it zero for the first test, I'd immediately have seen that the data was logically inverted, not reversed at all.

The bug? I'd put "btfsc STATUS, Z" into the rcv_bit macro instead of "btfss STATUS, Z," thus inverting the received data. The lesson here: choose test data with care.

Boe-Bot

Just two days before this column deadline, I received a package from Parallax (www.parallaxinc.com), and in it was their newest low-cost robot kit, "Boe-Bot." "Boe" stands for "Board Of Education," one of their BASIC Stamp 2 experiment boards intended for the education market (hence the name). I'd seen a couple magazine ads for Boe-Bot in the last month, so I was eager to get my hands on one (Photos 1-5).

Unlike Parallax's GrowBot, Boe-Bot has a CNC-machined aluminum chassis with lots of holes and slots for mounting components. This makes for a more solid, precise, and versatile mechanical base.

Boe-Bot and GrowBot use the same servos, drive wheels, and tail roller. The wheelbase is about the same, but Boe-Bot has an inch wider tracking width, making it more stable. It would make a great robot fire fighter for the contest in Hartford.

Boe-Bot is simple to build and requires no soldering. The full kit (Photo 5) includes a manual and parts for experiments for $199.00. For $99.00, there's a mechanical-parts-only kit (no B.O.E.) for folks who want to use Botboards, SIMMSticks, Handiboards, etc., and, for you GrowBot owners out there, you can buy an upgrade (the aluminum chassis and some hardware) for $49.00. The GrowBot board mounts nicely on the center slots.

More on Boe-Bot when I've had time to play with it.

S.A.M.

The second kit has been on my shelf for <mumble> months waiting

for me to find time to build it. It's called S.A.M., Small Android Model (Photos 6 and 7). Those of you who remember Topo and B.O.B. will instantly recognize S.A.M.'s lineage.

For those of you who aren't familiar with ancient amateur robotics history, Topo was a three-foot-tall hobbyist robot from the early 80s, and B.O.B ("Brains On Board") was Topo's smarter brother. Topo was unique in that it used only two drive wheels with no casters or skids.

The trick was that the wheels were tilted fairly steeply so that Topo didn't run on the rims of its wheel so much as the sides. This tilt, along with a low center of mass, made Topo inherently stable (mostly). Actually, the old Topos wobbled like Weebles. And, like Weebles, they didn't fall down (mostly).

S.A.M. is a smaller, lighter version of the Topo idea from Norland Research (www.smallrobot.com). The basic kit, without wheels or servos, costs $29.95. For that you get two vacu-formed ABS body shells, a preformed vinyl servo mounting bracket, and a square-tube chassis with cutout for a four AA-cell battery holder.

For another $29.95 you get servos, Dubro rubber wheels, and mounting hardware. You can fit most popular robot controllers inside, including a solderless breadboard. S.A.M. is about 14 inches tall and the body shell and chassis weighs just 12 oz.

The workmanship of the parts is pretty good, but this is definitely not a snap-together kit. You'll need to do some cutting, drilling, filing, and gluing to fit everything together.

Decorative stickers come with the kit to jazz S.A.M. up, or you can do your own custom paint job. But, for under $60.00, you'll have the coolest-looking robot on the block. You'll be hearing more about S.A.M. in the future.

Lonely Gearhead Contest

Over the years, I've gotten tons of letters and E-Mail from folks who are convinced they are the only robot builders in their area. Sometimes, these people live in places where there are vibrant amateur robotics groups, such as Seattle, San Francisco, or Hartford.

Others come from isolated places in third-world nations. The two things they have in common are the burning desire to build robots and the need to get together with other robot builders.

I try to connect these people up with any local robotics groups I'm aware of, because there is no substitute for sitting down with another gearhead to compare notes and 'bots.

To help our lonely brothers and sisters, I propose that anybody anywhere who wants to find a local club or get one going should send me a letter or E-Mail. Also, anybody who has a club going should give me contact information. Those listings I receive by December 1, 1999 will make it into my January 2000 column.

Send me contact names, addresses, URLs, E-Mail addresses, phone numbers, etc., whatever way you would wish other robot builders to get in touch with you. If you have a club you want folks to know about, drop me a line. Likewise, if you are looking for a club.

To sweeten the deal, all who respond by December 1st will get their names thrown in a hat; I will randomly select one person to receive a complete Parallax GrowBot kit, free of charge. Real names and addresses only, please, and no names of my relatives or friends will go in the hat.

So, let's hear from you. **NV**

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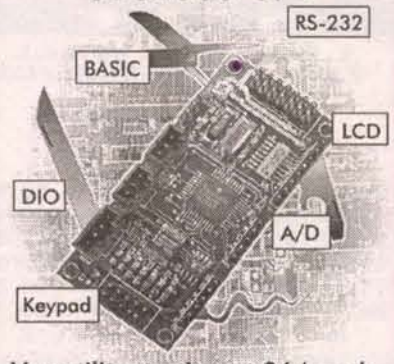

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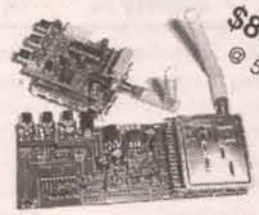

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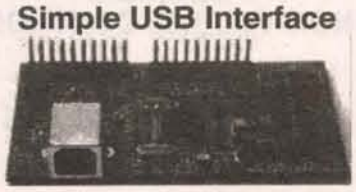

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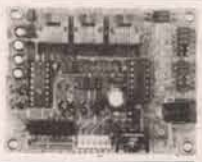

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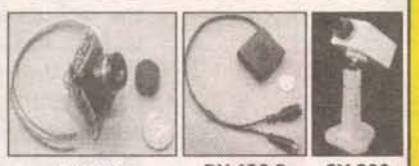

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SPDT	D134	6A/125V	Solder	.77	.67
on-off-on		3A/250V	Solder		
DPDT	D133	6A/125V	Solder	.77	.67
DPDT	D135	6A/125V	Solder	.92	.82
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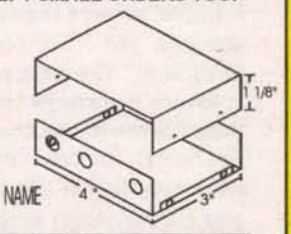

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ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware, software, circuits, electronic theory, troubleshooting, and anything else of interest to the hobbyist. Feel free to participate with your questions, as well as comments and suggestions. You can reach me at:

TJBYERS@aol.com
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What's Up:

How about some **vintage car electrical fixes** and **upgrades** — two to be exact. How to get that buzzing bee out of your bonnet, or put a **neon lamp** in one. Don't understand my **schematics**? I'll tell you how to read them. Finally, let's **put Y2K fears to rest** — lots of suggestions and testing info. Ready for the Holidays? **Check out these Web sites**; I already have and I like them a lot.

Modem Tester Still Alive And Well

Q - In your Jan. '99 column, you referred to a Web page that had a modem speed test. That page is no longer there. Any idea were to find it or another modem speed test?

Jim WDODIA
via Internet

A - This Web site (http://homepage.tinet.ie/~leslie/testpage.htm) is still valid, but AOL and other Internet servers stumble on it. Sometimes you get the message "file ... GIF could not be found" or "404 file not found." The best way to access this modem testing software is through Lycos. Simply bring up Lycos (http://www.lycose.com), type in "modem speed test" in the Search for box, and press Enter. The modem software specified in the column will be your first option. If you encounter an error message, either say OK or Cancel the error message and continue. If worse comes to worse, bail out and try again at a different hour. This is a very busy web site. It's strange that when I went searching for the perfect modem tester I had to really ferret out this software, which at the time was obscure. Since then, it's become the preferred choice and is highly recommended by computer specialists.

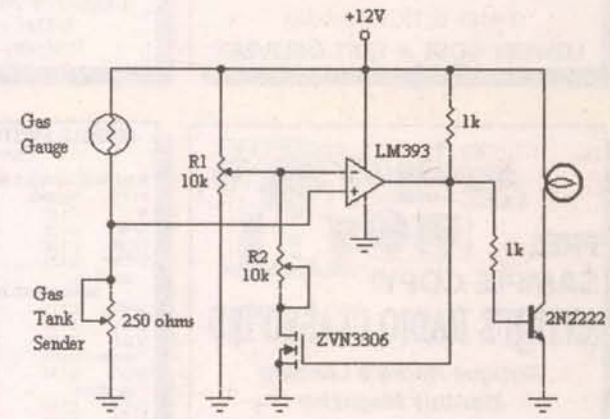
Vintage Car Low Fuel Lamp

Q - I am restoring a vintage car and I want to add a circuit to monitor the fuel level. The gas tank sender to the fuel gauge is about 250 ohms when empty and goes down to about 50 ohms when full. Obviously, the 12 volts goes through the meter and then to the variable resistor in the tank. Low ohms (full tank) gives a high reading and high ohms (empty) makes the meter read on the low or empty scale. I'm looking for a circuit that will turn on a light when the voltage drops to a certain point and stay on until the voltage rises (tank refills). I want to hook the monitor circuit across the meter and when the voltage drops down to whatever the 1/4 tank reading is, a light comes on as a reminder.

Frank Schwartz
via Internet

A - Your vintage gas gauge uses what's called a "hot wire" meter. The way it works is that there's a needle connected to a resistive wire — probably NiCr. As the wire heats up, it stretches in length which, in turn, causes the gas gauge needle to point towards FULL. As the fuel level drops, the current through the wire decreases and its length decreases — which causes the pointer to tend toward the EMPTY mark. The gas gauge and fuel tank resistance are balanced so that the needle spans the desired range. Now you know why the fuel gauge takes time to "warm" up to the right reading. Actually, this was intentional: A heated wire takes time to respond to level changes, which minimizes sloshing fluid levels in the tank.

What you need is a comparator circuit that triggers when the voltage across the level tank resistor reaches a certain level. As the tank empties, this voltage will increase, not decrease. When the trigger point is reached, the output of the comparator goes high and turns on the 2N2222 transistor — and the lamp. I don't know where you want the EMPTY light to trigger, so you'll have to do that by rotating R1 to the desired spot. My guess is 7 volts, but that's only a guess. Run the tank down to the point where you want the lamp to light, and adjust R1 so that the lamp just goes on. R2 adjusts the hysteresis of the comparator. Hysteresis provides a dead-band where the voltage has to exceed a high voltage and low voltage to change the logic state of the comparator's output. This is needed to keep the lamp from winking on and off around the trigger point. Don't make the hysteresis too wide, or you'll have trouble turning the light off when the tank is filled. Again, you'll just have to experiment until you find the right setting. What's nice about this design is that these two adjustments aren't interactive like most comparator adjustments are, so the setting of one won't affect the other.

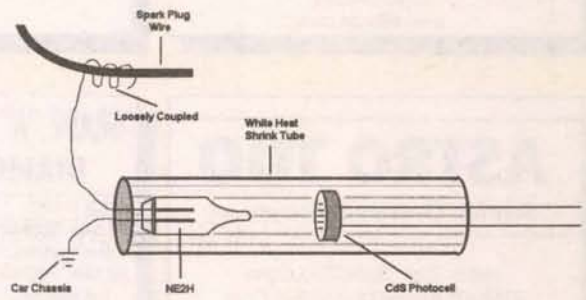


Neon Lamp High-Voltage Sensor

Q - I just read your column in the Aug. '99 issue. Your response to the question titled "Auto Tune-Up" came dangerously close to answering my question. I need some sort of inductive pick-up to detect the spark from a racing go-cart, that will provide a countable input to an Atmel microcontroller. I'm testing a circuit that uses a 100uH coil and op amp, but the coil is too large for the application. You mentioned using an "NE2H neon lamp coupled to a homemade optical sensor." Can you elaborate? Pointers? Web site? Any other inexpensive ideas?

Joe Knight
via Internet

A - Oddly enough, neon lamps don't need a direct connection to a voltage to light. Like fluorescent lamps, the presence of a high-energy field can cause them to glow. That's the idea behind this design. Place one lead close to a high-voltage source and ground the other, and you have light that can illuminate a photocell which, in turn, can trigger a logic circuit. The trick is in the light-to-photocell coupling, which is best done using white (not black) shrink tubing. Here's how the assembly looks.



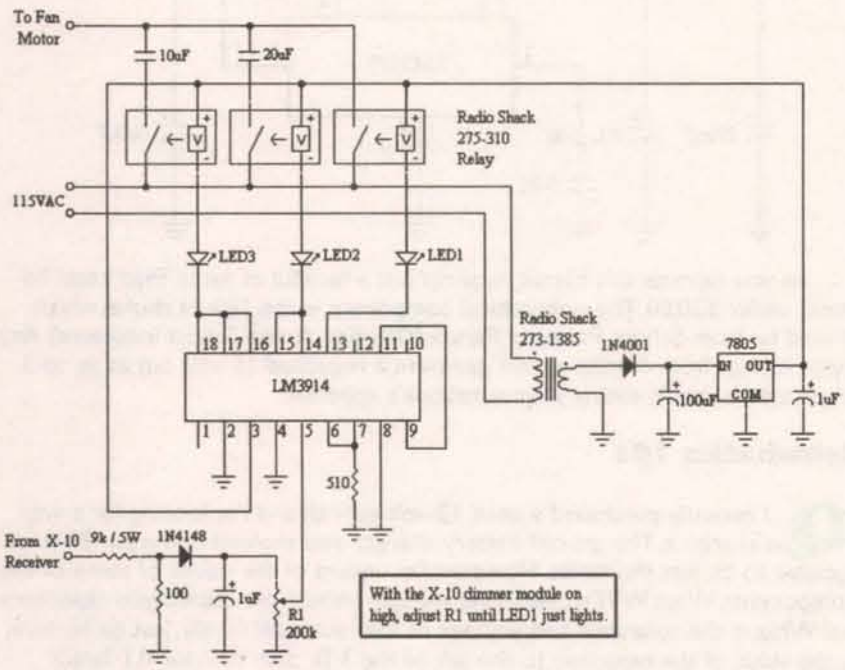
Place the NE2H and CdS photocell as close together as you can inside the shrink tube, crowding is allowed, then apply heat. This part of the operation is the most critical. Once done, wrap a couple turns of wire from one lead of the NE2 lead around the spark plug wire and return the other to ground. On the other end of this assembly, you're on your own. When the lamp lights, the resistance drops. As to how much depends on the CdS photocell. I've always used CdS photocells, but I don't see why a phototransistor won't work given the proper electrostatic precautions.

Ho Hummm ...

Q. I recently bought a Leviton DHC X-10 Inductive Dimmer Switch module. The ad says it's designed for fans and other inductive loads. But when I tried it on my ceiling fan, it caused a loud, annoying hum. The hum is coming from the motor, and is loudest at high speeds. SmartHome's tech support said it's common in some fans, and offered to refund my money. But that leaves me without a speed controller. I'm considering replacing the triac inside the switch module with a Teccor "Alternistor." The description for this part says it has "been specifically designed for applications which are required to switch highly inductive loads, and has better turn-off characteristics than a triac." Would this improve the hum?

Randy Gamage
Rocklin, CA

A. Most quality ceiling fans are operated by capacitors, which create distinct speed "steps" like high, medium, and low. Solid-state variable speed controllers use pulse-width modulation to create a speed control range from low to high. Capacitor and solid-state electronics are not completely compatible, which leads to the hum that you hear. For quiet fan operation, capacitor type fan controllers are required, which means upgrading to an Alternistor won't change a thing. The fan will still buzz. Fortunately, I was able to find this circuit, which was conceived and designed by Ed Cheung PhD, that uses an X-10 controller to switch the fan's speed with NO HUM!



I've taken the liberty of streamlining the circuit just slightly, but essentially it's Dr. Cheung's design. (The original circuit can be found at http://www.mindspring.com/~dr_ed/automa/nohum.htm.) Basically, the circuit works by switching different-value capacitors in series with the motor winding — just like the pull-chain does. The opening and closing of the solid-state relays is controlled by an LM3914 dot display generator, the same kind used to indicate volume levels on audio equipment. As the voltage across the input (pin 5) increases the LEDs move up a linear scale. This voltage is derived from the output of an X-10 receiver, which doesn't have to be an inductive dimmer. A less expensive lamp dimmer will work. There are 10 outputs from the LM3914 that can light up to 10 LEDs. What Dr. Cheung has done is wire the outputs to the "coil" of the relay, turning it on. The LEDs are used to indicate which relay is on at the time. To calibrate this circuit, turn on the dimmer to high, then adjust R1 so that LED1 just lights. Dimming the X-10 controller will cause LED1 to drop out and LED2 to light, indicating that a 20uF capacitor is now in series with the fan motor. The smaller the cap, which has to be 250V non-polarized mylar, the slower the fan spins. Don't attempt to use electrolytics in this circuit even if you place them back-to-back because the current draw may be too much for them and they will eventually pop like fire crackers. What I'd do is buy replacement caps from the manufacturer or (if you know what you're doing) remove the original caps from the fan and use them in this circuit.

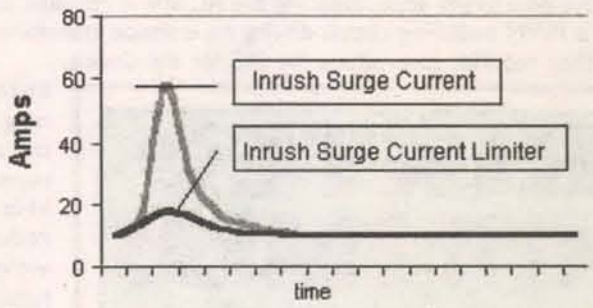
Keep That Cool

Q. I ask your pardon for taking advantage of you again, but when I sent you the last E-Mail asking questions about my vintage car project, I neglected to include an important one. Here's the problem: I am using two 12-volt automotive relays with SPDT contacts to activate two radiator fans that come on when the sensor in the radiator is closed (to ground). Each fan draws 7 amps and rather than have both come on at the same time, I was wondering what kind of circuit you could suggest that delays the second fan from coming on until two seconds later so that the total 14 amps isn't placed on the electrical system at the same time. First 7 amps, a two-second delay, and then the next 7 amps. Do you have a simple solution?

Frank Schwartz
via Internet

A. Sorry, one question per customer ... just kiddin'. Actually, you have a legitimate concern here because what you're seeing isn't 14 amps when the fans kick on, but more like 140 amps of in-rush current. Have you ever noticed that when your refrigerator or dishwasher starts up, the lights dim slightly (actually, in my 1909 apartment, they go dark!). That's because everything from motors to lamps draw more current when they start than they do when humming along. There are two ways to curb this problem.

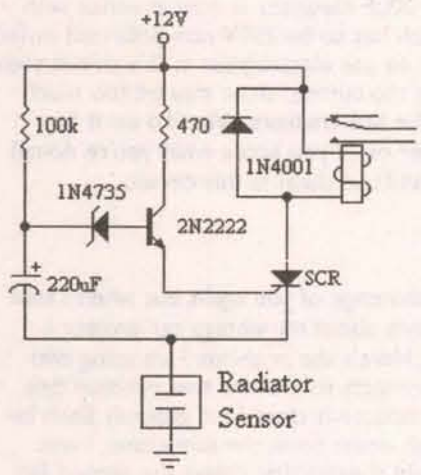
My first suggestion is to use an NTC (negative temperature coefficient) thermistor that's specifically designed to prevent high-current inrush. These devices, often called an inrush current limiter (ICL), have a high resistance when cold, and a lower resistance as they warm up. This characteristic limits the initial input current, but allows full current to flow after the termistor warms up. Here's how it looks graphically.



This solution is very cost-effective and available from many sources, including **Digi-Key (1-800-344-4539; http://www.digikey.com), Mouser Electronics (1-800-346-6873; http://www.mouser.com)**, and even your

local appliance repair shop. All you have to do is match your 7-amp requirement to the steady-state current of the ICL.

However, if you still insist on sequencing the relays, the simplist solution I can come up with is an SCR in series with the second relay coil. Here's how it looks.



What I initially intended to do was a simple RC time constant to trigger the SCR's gates, until I looked at the specs. Guess what? Most SCRs need 20 mA of gate current to trigger. (Surprise, Surprise!) Using Ohm's Law, R1 has to be 550 ohms or less, which means we're going to have a humongous capacitor. Which is the reason I inserted the 2N2222. Even at its worse, it provides 100 hFE of gain — typically 300 hFE. (hFE is DC voltage gain as opposed to hfe, which is AC voltage gain. Two different parameters.) That means we can scale down our calculations by a factor of 100, which I've kinda stabbed at. If you insert this circuit in line with the relay coil, it should provide a two-second delay, but don't quote me on that. At least I've put you in the ballpark, so experiment to find the optimum setting. Personally, I'd go with the ICLs.

A Real Sound Blaster Needs Power

Q - My latest project is a 1kW audio power amp, but the only one I can find that's simple enough to build calls for a ±85-volt dual power supply. Can I just rectify the AC mains to obtain this voltage and, if so, how do I derive a common ground? I suppose I can use an isolation transformer to get these voltages, but these things weigh 31 pounds and cost nearly $200.00. Is there any other means to power this beast?

Garry J. Iman
via Internet

A - How about a dozen gel-cell batteries in series — or not? According to my calculations, the power supply must be capable of providing 6 amps at 170 volts — which is a very tall order. Fortunately, there is a simple solution called an off-line power supply — exactly the same kind used to power your desktop PC, but on a larger scale. Basically, the AC line is rectified and then processed by a PWM switching circuit driving an isolation transformer. The secondary is then rectified to produce the DC for the device.

Instead of running at 60 Hz, the switcher runs at 100 kHz, which reduces the weight and heat of the power supply. Because of the currents and voltages involved (the input power is equivalent to that used by a clothes iron), this isn't a project you want to take on without prior experience in winding large power transformers. I suggest you contact one of the following vendors. You might discover that it's cheaper to buy than build.

Astec America
1-888-412-7832
http://www.astec.com/

PowerQuotes
http://www.powerquotes.com/

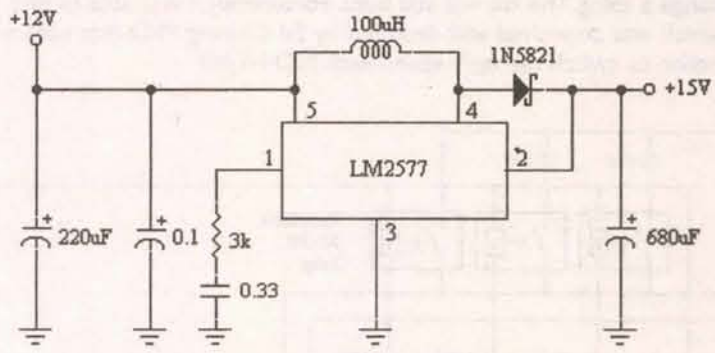
Opt Industries
908-454-2600
http://www.optind.com/SinglePhase10_84.html

On The Road Again

Q - I was wondering how difficult it is to make a DC adapter that converts 12 volts to 15 volts at 3 amps? It's for mobile use of a laptop, and I thought I could make one cheaper than buying (about $100.00). What do you think? Obviously, I'm a rookie.

John D. McGuire
via Internet

A - Missed my "Switching Voltage Regulator Basics" series (May & Jun. '99), eh? Check it out, because it has a wealth of information on voltage conversion regulators for "rookie" users like you, plus plenty of tips for the pros. Back issues are available. Meanwhile, I can show you how to do this cheaply using an LM2577-15.



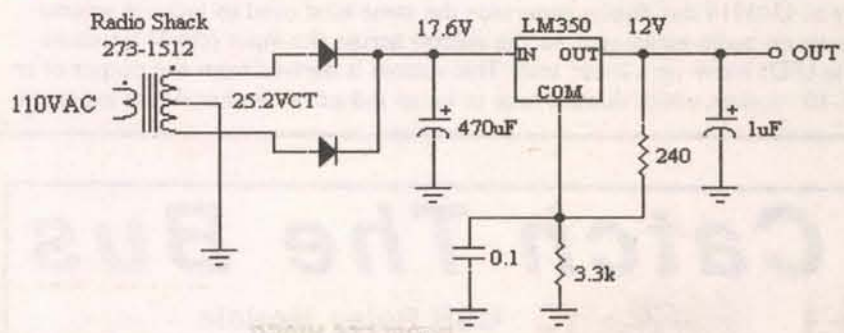
As you can see, this circuit requires but a handful of parts. Total cost? I'd guess under $20.00. The only critical component is the 100uH choke, which should be from Schott, Pulse, or Renco (Digi-Key stocks Schott inductors). Any input voltage from 5 volts up will generate a regulated 15 volt out at up to 3 amps, which should satisfy your notebook's appetite.

Schematics 101

Q - I recently purchased a used 12-volt gel-cell and I'm looking for a way to charge it. The gel-cell battery charger you showed in the Jul. '99 issue appears to be just the ticket. However, I'm unsure of the values of some of the components. What WVDC (working voltage) should the electrolytic capacitors be? What is the tolerance and wattage of the resistors? Finally, just to be sure, is the value of the capacitor to the left of the 3.3k ohm resistor 0.1 farad?

John Crawford, Jr.
Hamburg, NY

A - Okay, here's a quick lesson in reading schematics. Let's use the simple circuit below for this discussion.



This is a simplified version of the front end of the gel-cell charger shown in the Jul. '99 issue. First, the transformer, which reads 25.2VCT. That means 25.2 volts center tapped. The center tap is returned to ground, so there's 12.6 volts (V = 25.2/2 = 12.6) across each winding. The two diodes form a full-wave rectifier, the output voltage of which is 1.4 times that of the AC input voltage, or 17.6 volts (V = 12.6 x 1.4 = 17.6). So the working voltage of the 470 uF capacitor has to exceed 17.6 volts. You absolutely want the WVDC of an electrolytic capacitor to be higher than the circuit voltage, but not excessively higher for reasons that go beyond this discussion. For this circuit, I'd choose a 35V capacitor, not the 50V or 100V version. This voltage is then input to the LM350 voltage regulator, where it's reduced to 12 volts. This means that a 1 uF, 16V electrolytic would be the perfect choice. Now about the capacitor to the left of the 3.3k resistor: It's a ceramic disk, which are typically rated at 50V. Unlike

electrolytics, any voltage above the working voltage is acceptable, which means the 100V version is perfectly okay. However, the physical size of the cap grows larger as the WVDC increases. As for the value, it's 0.1 uF — microfarad not farad. Capacitors with a schematic decimal value of 0.99 and lower are expressed in microfarads (uF). Values of 1.0 and beyond mean pF or uF, and are identified as such on the schematic. For example, the 470 uF cap on the above schematic; a smaller value cap would have said 470 pF.

About the resistors. Wattage is equal to voltage times current. Here you can use math to calculate the power dissipation (P = E2/R = 122 / 3300 = 144/3300 = .04 watts). Unless indicated otherwise on the drawing, a 1/4-watt (0.25W) resistor will work. In many cases, so will a 1/8-watt (0.125W) resistor, but do your math first. If the value of the resistor is below 1k (1000 ohms), the nomenclature on the schematic is in ohms — like the 240-ohm resistor shown on our example. This normally includes values down to 0.1 ohms and below. Above 999.999k, the nomenclature reverts to 1M (one million ohms). The next step is 1B (1000M), one billion ohms. Beyond that, the only values you'll find higher (trillions of units) are the input impedance of an op amp and the national budget. In all but a few cases, resistor tolerance isn't an issue. Whatever RadioShack has on the shelf (typically 5%) is just fine. If tolerance is a critical factor, it will say so on the schematic. Now get off your duff and build that charger!

Y2K Woes

Q. I'm worried about the Y2K syndrome. A while back you gave the Web site of a Y2K test program, but I've misplaced that issue. Can I have that address again?

Ruth McDougall
via Internet

A. As the Millennium nears, I get more and more requests like this. Fortunately, the Internet is littered with Y2K test software, some better than others. Here are some of my favorites.

Microsoft: http://www.microsoft.com/technet/year2k/pca/pca.htm

PC Magazine: http://www.zdnet.com/pcmag/special/y2k/

PC World: http://www.pcworld.com/online_feature/1707/countdown2000/

ZD: http://hotfiles.lycos.com/cgi-bin/texis/swlib/lycos/mlt.html?link=1&Utext=compliance+system+utilities+y2k+check+hardware+problem+file+application+program+&UTcat=utilities&UTsubcat=system+utilities

Be Leery of Y2K Cassandra's

The following is directly from the pages of Microsoft's Web site.

TJ Byers
Q & A Editor

There is a hoax E-Mail in circulation on the Internet concerning the Y2K compliance of Windows 95, Windows 98, and Windows NT. There are various versions of this mail which resemble the text below:

"Every copy of Windows will fail on January 1st unless you fix it now, to fix it ..."

1. Click on "My Computer."
2. Click on "Control Panel."
3. Click on "Regional Settings."
4. Click on the "Date" tab. Where it says, "Short Date Sample" look and see if it shows a "two digit" year. Of course it does. That's the default setting for Windows 95, 98, and NT. This date RIGHT HERE is the date that feeds application software and WILL NOT rollover in the year 2000. It will rollover to 00.
5. Click on the button across from "Short Date Style" and select the option that shows mm/dd/yyyy. Be sure your selection has four Y's showing, not two.
6. Click "Apply" and then click on "OK" at the bottom. Easy enough to fix. However, every single installation of Windows worldwide is defaulted to fail Y2K rollover.

"Thanks and have a great day"

Facts about Windows 95, Windows 98, Windows NT, and Y2K ...

Microsoft Windows 95, Windows 98, and Windows NT are compliant assuming all recommended actions specified in the respective compliance documents have been taken. The steps above are not required actions and do not have to be performed in order to obtain compliance.

· The short date format style in Regional Settings is a display setting only.

· Dates are stored and processed by Windows in a four-digit format regardless of the short date format style selected in Regional settings.

· Customers can use the regional settings tab to adjust how the date is displayed (e.g., mm/dd/yy or mm/dd/yyyy).

· In order to avoid ambiguous dates, Microsoft recommends using four digits when entering date data and expanding the date field in regional setting to four digits. However, this is not required to attain compliance.

Last Updated: Friday, August 20, 1999 - 11:30 a.m. Pacific Time

Holiday Helpers

The holidays will soon be upon us, and our thoughts turn to what else, feasts. However, if you're growing bored with the same old holiday fodder, check out these Web sites for fresh fare.

SOAR — http://soar.berkeley.edu/recipes/
Searchable database for recipes

Chef Talk — http://www.cheftalk.com/
Tips from the pros

FoodLines — http://www.foodlines.com/
For People Who Have A Passion For Food!

The Taste Of The Web — includes links to other sites (low air fare, etc.)
http://www.epicurious.com/

Mixed-Drink.com — http://www.mixed-drink.com/
Shaken or Stirred?

The Ultimate Undo

If you frequently install new software, change system settings, or delete a lot of files, Windows can easily become corrupted — a situation that often brings your system to its knees. Don't you wish you could turn the calendar back to just before this happened? Well now you can. Three Windows utilities claim to do just that.

WildFile's GoBack (1-888-945-3345; http://www.goback.com) monitors your operating system and records any changes to your hard drive. Should you find yourself in the Twilight Zone, you can get out of trouble by simply turning back the "clock" to a time before the problem occurred. GoBack also lets you restore a specific file instead of the whole system. Moreover, it can restore the system even when Windows won't boot.

PowerQuest's SecondChance (1-800-379-2566; http://www.powerquest.com/usindex.html) works by taking periodic (both automatic and manual) snapshots of your system. You can name each snapshot, then choose the one you think is best when the crash occurs. This is a great feature because not all problems are immediately noticeable, and the ability to select from more than one time frame is a big plus. The program prompts you when you run out of disk space, thus allowing you to delete old snapshots before it's too late. However, SecondChance cannot undo changes made in DOS like GoBack can.

Unlike GoBack and SecondChance, which monitor your system and record the changes on the hard drive, Duomark's 9Lives (310-493-7711; http://www.duomark.com/9Lives) works by creating a folder called C:\9LIVES. When new software is installed, the newly loaded software and system changes are saved in this folder. This allows you to inspect the new software to see if it works properly. If it does work as advertised, simply click on the 9Lives icon and reboot the PC; if it doesn't work or is causing problems, get rid of it using another 9Lives button.

You can download demo versions of all three programs by going to the Web sites listed above. The cost of GoBack and SecondChance is $69.95, whereas 9Lives sells for $49.95. All three companies also offer free Y2K system checking software.

TJ Byers
Q & A Editor

MAILBAG

I just read your reply to Jim Allen in the Oct. '99 issue and, as an "expert" (35 years in the satellite design field), I have several problems with your response.

First DSS (Digital Satellite System) is a trademark of Hughes; other systems are known as DBS (Direct Broadcast Systems). However, Jim Allen is using a 10-foot antenna that is neither of these systems but rather on a TVRO (TV Receive Only), which is either C or K band, and until recently was using exclusively analog TV signals. Neither of these systems use circular polarization, but use orthogonal linear polarization, H or V. Usually adjacent channels use different polarizations to prevent interferance. The receive antenna is sent a signal from the receiver to select the proper polarization. A fine adjust is provided to compensate for polarization shift in the atmosphere. The only satellites now using CP are the Intersats. These were indeed spin stabilized satellites, but the spin has nothing to do with the polarization used. Using CP does allow for separation (LHCP and RHCP) and the receive antennas do not need fine polarization tracking. All of the present satellites are three-axis stabilized, and can indeed guarantee either horizontal or vertical polarization.

Incidently, circular polarizations as generated by combining two linear polarizations in quadrature phase one-quarter wavelength apart in space. The "spin rate" is at the RF carrier frequency and has nothing to do with the satellite's spin.

Hope this clears up some more misconceptions you may have inadvertenly perpetuated.

Virg Wall K6EVE
Los Angeles, CA

Response:

I thank you for finally capsulating what I've been trying to say over the last few months — a bite at a time. H and V polarization is not LHCP or RHCP, despite what most DSS and DBS retailers would have you believe (RadioShack frustration!). It's one of the those great myths of satellite TV. Furthermore, DSS is DBS, but neither are TVRO. Hooray, and thanks!

TJ Byers
Q & A Editor

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The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

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Birmingham 35209

RT Systems
Amateur Radio Supply
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Huntsville 35802

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Chandler 85224

Batteries Plus #334
1155 S. Power Rd. #108
Mesa 85206

Batteries Plus #331
2404 E. Bell Rd.
Phoenix 85032

Batteries Plus #332
3415 W. Glendale Ave. Ste. 4
Phoenix 85051

Batteries Plus #333
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Tempe 85282

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Tucson 85713

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642 E. 39th Pl. Ste. 5
Yuma 85365

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Tullamarine 3043
www.dontronics.com

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Cucamonga 91730

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Santa Ana 92705

All Electronics
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Los Angeles 90006

14928 Oxnard St.
Van Nuys 91411

Allen's To Go
13461 Hwy. 88
Lockeford 95237

Alltronics
2300-D Zanker Rd.
San Jose 95131

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716 N. Fairfax Ave.
Los Angeles 90046

Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505

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2985 E. Harcourt St.
Rancho Dominguez 90221

Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621

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113 W. Harding Way
Stockton 95204

Harold's Newsstand
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San Francisco 94102

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1814 E. Ball Rd.
Anaheim 92805

HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841

3500 Ryder St.
Santa Clara 95051

5681 Redwood Dr.
Rohnert Park 94928

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371 N. Johnson Ave.
El Cajon 92020

JK Electronics
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Westminster 92683

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Studio City 91604

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108 W. 25th St. #D
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Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727

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Riverside 92503

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Los Angeles 90038

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Panorama City 91402

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Citrus Heights 95610

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Sacramento 95818

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2525 Jones St.
San Francisco 94133

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San Jose 95123

Video Electronics
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San Diego 92105

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ACE Electronics
501 Linwell Rd.
St. Catherines, ON L2M 2R2

Com-West Radio Systems Ltd.
8206 Ontario St. #100
Vancouver, BC V5X 3E3

Emma Marion Ltd
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Vancouver, BC V5K 1Z5

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3214 Douglas St.
Victoria, BC V8Z 3K6

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Denver 80206

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Melbourne 32935

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Fort Lauderdale 33301

Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309

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2245 W. Fairbanks
Winter Park 32789

Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

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Tower Records
3400 Around Lenox Dr. N.E.
Atlanta 30326

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525 Lotus Blossom Ln.
Ocean View 96737

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4211 Waialae Ave.
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Boise 83714

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Bloomingdale 60108

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Wichita 67213

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Independence 64054

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VSTG-22
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Carle Place 11514

350-370 Route 110
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New York 10023

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New York 10003

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Nashville 37203

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Houston 77063

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Seattle 98188

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Bellevue 98004

20 Mercer St.
Seattle 98109

WISCONSIN

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Greenfield 53220

Cudahy News & Hobby Ctr.
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Cheyenne 82001

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You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

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Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 92879, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

Does anyone know of a good reference book or where I might find any kind of information on troubleshooting strobe lights that work off of the 12-volt system in a vehicle?

11991 **Charles**
via Internet

I have a robotics project that has a 12-volt system. I need to reduce the voltage to 4.8 and 9.6 volts to run servos and accessories. Also, the main drive motors when activated, lurch forward and peel out.

I need a way to reduce the voltage to three volts, then gradually increase to 12 volts over five seconds. I would like the five seconds to be adjustable, if possible.

11992 **Chad Giddings**
Spokane, WA

I need hook-up schematics of E-Lab's serial-to-parallel interface (EDE 1400) and parallel/serial transceiver (EDE 300) to interface a three-wire serial input to parallel printer.

11993 **Terry K. Laraway**
Bremerton, WA

I need a source and supplier (company name or distributor address and fax number) for electronic radio tubes.

I repair and restore old radios and the tubes are difficult to find.

11994 **Lloyd H. Berg**
Ontario, Canada

I have a nice generator that I would love to get working again, if possible. This was given to me by a friend, who found the generator (taken apart) at a yard sale. I have since rebuilt the engine.

This generator is an AC/DC generator/starter. The generator is suppose to start the engine, then start generating power.

The manufacturer seems to be out of business.

The generator appears as if it was used in a motor home (RV) because it is an AC/DC type generator, used for giving light, as well as charging the motor home's battery (I think).

Here is all the information that is available.

Manufacturer's name: Ralph Electric Plants, Inc. Last known address: Chula Vista, CA. Model# PKN, serial# 76091980U, spec.# 542510. Color: aqua, more a bluish metallic look. Ratings: AC 3KW at 110 volts; DC 12 volts at 3 amps, DC amps at starting mode unknown. Engine: Techumsie 7 HP tapered shaft, all cast iron block. Age: very old, possibly 20 years plus.

The armature/rotor is two in one. It has a serrated commutator and slip rings. The slip rings are the AC and the commutator is for the DC.

The field/stator has four leads coming out from the windings. Two leads are heavy gauge wire that I think are used for the DC, and the other two are thinner and used for the AC. (Maybe the heavy gauge wire is needed for the starting of the generator.)

I need some information on how to wire this back together to make it work again, or who was the manufacturer for this generator.

11995 **Ray Samples**
via Internet

Does anyone know of a product that can block Caller ID in Australia? When I make a call, I don't want the other party to see my phone number on their GSM digital cellular phone display. I have 30 analog lines.

11996 **Joe Dooman**
Australia

I need information and sources for the following components.

1. Volume control double 50K to mixer Gemini PMX2000.

2. SVI 3206 integrated circuit for amplifier (Tecnices).

11997 **Rodrigo Paba**
Holtville, NY

I want to experiment with varying light intensities using ordinary household light bulbs.

I need a circuit that will automatically and very slowly, cycle voltage up and down between 60 VAC (or so), and 120 VAC, taking as much as 20 minutes to go all the way up and as much as 30 minutes to go all the way down. This rate should be adjustable to as fast as eight minutes in each direction to cover the maximum voltage span.

The low-voltage limit must be adjustable higher to establish preferred minimums.

Ideally, a variety of cycle and ramping patterns could be experimented with, where **1**) the high limit and low limit would automatically shift each cycle; **2**) the rate of change could stop and hold, for variable lengths of time, at various plateaus before continuing on. The more adjustability, the better.

11998 **Edgar Montgomery**
Los Angeles, CA

ANSWERS

ANSWER TO #109912 - OCT. 1999

I need program code numbers and instructions for extended transmit frequencies for my Dai AT-600 dual band transceiver.

To expand the frequency coverage of your ADI handheld, try the following: press function 0, then enter the code 14623, the radio will beep, but the display will show no response; then enter 11289, the radio will beep and display "key ok ver ????"

This works on my HT 204 (not tried on at 600). It will still not transmit in the 800-900 range.

Anonymous
via Internet

ANSWER TO #109910 - OCT. 1999

Need pinouts for the Sony HVM-302 Watchman Camera?

It should be 6V DC positive, negative, audio, and video.

This first camera in the Watchcam series set a standard for quality performance and small size. It was the first of the now-common miniature, quality video cameras typically used for surveillance.

The HVM-302 was popular about 15 years ago when it came out, and thousands are still in use today. Believe it or not, this camera used a "tube," but still offered small size and low-current drain.

The camera has a 1/2" Saticon tube, with an 11mm F1.8 fixed focus, auto-iris lens. Sensitivity was 5 lux. The connector is a four pin, unique to this series — as far as I am aware.

If you look at the camera's connector (as opposed to the cable), with the key up, you will have four pins as follows: straight up (under the key) pin 1, 6VDC in; pin at 3 o'clock, pin 2, video out; pin at 6 o'clock, pin 3, common ground (power and signal); pin at 9 o'clock, pin 4, audio out.

Video out is composite, 1V P-P into 75 ohms, negative sync. Audio out is -5 dB into 10K ohms, or 450 mV RMS.

The camera draws approximately one watt with the auto iris open.

If you happen to have the official Sony cable, and you cannibalize it, the internal wires correspond to the

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

above as follows:

White	DC in
Blue shielded	Audio out
Plain shield	Common ground
Red shielded	Video out

Note that the camera will run fine long term on 12 VDC, but the companion FDM-402 monitor must not be connected to greater than 6 volts.

Steve Uhrig
Street, MD

ANSWER TO #99912 - SEPT. 1999

I bought a Toshiba T4600C notebook computer at a local hamfest. How can I bypass the power-on password?

I had the same problem on my Toshiba Tecra 500CS. The trick is, when asked to specify the password, simply press the "Esc" key. This works on most systems operating on Windows 95.

Thomas Ng
San Jose, CA

ANSWER TO #10999 - OCT. 1999

Need schematic/parts list/parts placement list for a Gateway Monitor CS11572FS. Also identity to part number 3H 15DF8.

I have horizontal waves traveling up the screen.

The Gateway Monitor with the grey line moving up the screen every four seconds is poor power supply filtering.

You are seeing the result of the 60 Hz AC power line being allowed into the monitor power circuits. This beats with the 59-3/4 Hz vertical sync frequency, and causes the grey bar to scroll up the screen taking four seconds to complete the cycle.

60 Hz - 59 3/4 Hz = 1/4 Hz, or one complete cycle every four seconds. The first place I would check is the electrolytic capacitors in the power supply.

It is likely they are not doing an adequate job of removing the 60 or 120 Hz ripple (depending on whether it is halfwave 60 Hz ripple, or fullwave 12 Hz ripple) before it gets to the voltage regulating circuitry.

If the ripple minimum voltage i.e., the valleys of the DC voltage is too low, this ripple is passed onto the power bus in the monitor where it beats with the vertical sync frequency.

The filter capacitor on the primary rectified source can fail to maintain this voltage above the voltage regulating minimum voltage, and when the AC ripple on the DC lines drops below the regulating voltage of the voltage regulating devices, which occurs on each alternating cycle of the AC Power.

Replacing this filter capacitor will hold the voltage between cycles from dropping below the minimum regulating voltage requirement.

You can carefully parallel a similar capacitor across the existing capacitor. If upon doing so, the grey band disappears, then replace the guilty capacitor. ***I said carefully, because the voltages present can be lethal.***

If there is a transformer, then the voltages will be as much as 80-100 volts, but probably lower. If it is a switcher, they rectify the AC power line coming in from the wall, and typical capacitor voltages can be 200 volts or more (120V x 1.414 for a simple half- or fullwave rectifier).

This, also coupled with the power line Ground/Neutral just touching one terminal of the capacitor, and anything grounded can produce a nasty shock. So, as I said, parallel the suspected capacitor very carefully.

Best is to connect with the power off, unplugged, and allow time for charged capacitors to drain off. Then apply power while keeping both hands in your pocket (well at least one hand, you need one to plug it in, and turn it on). If this eliminates the grey band, replace the bad filter

ANSWERS TO #109913 - OCT. 1999

I'm using a Bearcat BC235XLT "Trunk Tracker" portable scanner with a (BNC) rubber duck.

I would like to experiment with used/junked TV/FM antennas.

What antennas have omni directional reception, as well as the types used to aim at the signal source?

#1 The antennas you request for the various frequencies being a scrapped TV antenna will work. The main difference being the TV antenna is normally mounted horizontal, which provides horizontal polarization, and most public service use vertical polarization.

Mount the antenna vertical or rotated 90° from the normal mounting. Rabbit ears are omni-directional when mounted vertical, but typically are not tuned to the frequencies you might want to listen to.

The rods can be extended or compressed to approximately be at resonance. In most cases, this will not affect the operation. A log periodic-type antenna will provide a directional, antenna, and will typically be more closely resonant at multiple frequencies. It will, however, be directional, so some means of rotating the antenna would be desirable.

It also should be mounted with the elements vertical 90° from the original horizontal mounting. The boom will still be horizontal, only the elements are rotated to vertical. The direction of most gain is the smaller end of the antenna. Like an arrow pointing toward the desired direction.

You also mentioned using an "N" to "BNC" adapter. Typically, the RG 59, or RG 6 coax used with TV antennas, uses an "F" connector. I suspect this is the adapter you are using.

Ed Pruitt
via Internet

#2 This question deals with using TV/FM antennas with scanners. I also have a trunking scanner and for the past two years have enjoyed excellent reception using a RadioShack omni-directional FM antenna (part #15-2164, $15.00).

You will also need an BNC to F connector (part #278-251, $3.00) to connect your scanner to the FM coax.

I live in a valley where I get no TV reception (thank God for the Dish Network), but with my scanner, I catch calls 30 to 50 miles away. For $18.00, it's hard to beat.

Randy Boettjer
Oak View, CA

#3 The basic design for a good TV antenna is to make them one directional so that they eliminate ghosts caused by signals reflected from secondary sources.

The VHF low signals are below the TV band, the VHF signals are mostly in the gap between channels 6 and 7 and the UHF signals are in the UHF TV band.

A second factor to consider, is that the TV signals are horizontally polarized while the radio bands you discussed are vertically polarized. (Rabbit ears being in a V are in between).

You can mount a TV antenna with the elements vertical, but you still have to point it for best reception.

The antenna I found best in the application you described is a Discone. It is vertically polarized and can have a response from 30-1200 MHz. They are $59.90 from RadioShack, and are available elsewhere at ham radio sources (maybe cheaper). If that price is too steep, remove the elements from the TV antennas and make one.

Jim Schmidt
Deer Lodge, MT

capacitor with one of similar capacitance and, most of all, voltage rating. (It can be higher, but not lower.)

It is likely once you remove the faulty capacitor, you will see the seal blown, and electrolyte leakage under the capacitor or capacitors.

Often they use two or more in parallel to obtain the required capacitance, but staying within physical size constraints. So, if you find one defective, it is likely the parallel capacitors need to be replaced as well.

Ed Pruitt
Keller, TX

ANSWER TO #9993 - SEPT. 1999

Any suggestions on how to build a speech synthesis board for our BASIC II based robot? (It seems that the SP0256 chip is near extinct on the market right now.)

Please be advised that the SP0256A-017 voice processor and the SPR016-117 expansion ROM are both available from **A & A Engineering**, 2521 W. LaPalma, Unit K, Anaheim, CA 92801. Cost is $20.00 plus $1.50 S&H to USA customers. Phone: **714-952-2114**, fax: **714-952-3280**.

Anonymous
via Internet

ANSWER TO #10993 - OCT. 1999

I am interested in programmable logic controllers (PLCs). Can anyone recommend good training hardware and textbooks?

PLC use has increased dramatically in the past few years. While common on the factory floor for years, their cost, power, and convenience have made them attractive for all kinds of applications.

The configuration of a PLC (Programmable Logic Controller) is also very flexible. From standard contacts and coils (inputs and outputs) to ADCs and DACs, thermocouple inputs, and motor controls, RS-232 and ethernet connections, intelligent user interfaces, etc.

The PLC is an important tool, monitoring all manner of inputs, and controlling all kinds of outputs.

Numerous books have been written, and a large number of vendors make an even larger variety of products. And, while each family is uniquely different, there are some important similarities.

The main programming language is called ladder logic, so called because of the appearance of the logic diagram. With its vertical and horizontal lines, it appears much like the rungs on a ladder. Each rung being a particular element of the control logic. And like any computer program, each rung is typically executed in order or its placement in the program.

Each PLC family will have its own options for programming, though most include Windows-based graphical interfaces to ease programming. The software usually includes various utilities to show which addresses are used, what their signal types are, and what the addresses used might be.

Debugging usually allows a program to be stepped through sequentially, and the provide feedback on logic errors.

A good place to start is by requesting the free catalog (800 pages of info) from **PLC Direct** (now Automation Direct). They provide a number of system families, some of which are literally the same as units branded by other manufacturers, but at a lower price. Their entry-level PLC, the D0-05 series features: eight inputs, six outputs, 2K for ladder logic storage, two RS-232 inputs, etc. They can be reached at **http://www.automationdirect.com** or by calling **1-800-633-0405**. The programming software is reasonably priced, and many of their specifications and user's manuals can be downloaded from their web site. Check the section on Books as well.

Rick Nelson
Newport News, VA

ANSWER TO #99920 - SEPT. 1999

I need a keyboard for an old EPSON ActionNote 500C. The plastic foil PCB has broken traces, so the enter key and couple of keys around it don't work.

I need this dinosaurus for work (modem compatibility reason).

If someone has this notebook with a broken screen and good keyboard, I'm willing to buy it.

The Epson 500C has a design flaw. There is a screw under the F8 key that ends breaking the film ribbon cable. Remove it and throw it away. If you still need spares, let me know.

Miguel
via Internet

ANSWERS TO #10994 - OCT. 1999

I need to project the image from an 8mm camcorder tape onto a screen larger than a television screen, for a club with a number of people viewing it. Can anyone suggest a technique?

#1 Obviously, a projection TV is out of the question price wise, but a fairly good version would be to acquire a computer LCD projection frame, and place it on an overhead projector.

The device needed is an older version prior to current day standards of VGA. Preferrably one in the CGA or composite video input. I found some of these maybe three years ago. They were about $50.00 and slightly used.

Usually, the CGA also had a composite video input. Some manufacturers of these units were sharp, and in focus. They are probably out of production now, since the current standard is VGA. I have seen some adapters built that will convert composite to VGA so, if you find a VGA, then you must also find a composite to VGA adapter.

The colors are not as brilliant as they are with a TV, or even a projection TV, but they will produce a usable image.

If you have a composite version or a converter, simply connect the video output of the 8mm camcorder to the composite input of the projection screen. Place the screen on the overhead projector, and you have a large screen display.

Ed Pruitt
Keller, TX

#2 It's easy to project the image from any video source (like your 8mm camcorder, a TV tuner, etc.) or from a computer, on a large projection screen. You simply need to use a "video/data projector."

These projectors were formerly in the "professional only" category for price and for ease of operation. Older projectors used three high-power CRTs, one for each primary color, and three lenses, optical convergence of the three images on the projection screen was painful, at best.

The high-voltage power supplies would sometimes self-destruct, and I have seen CRTs overheat and implode!

In the last few years, the technology has become simple and reliable, the images have gotten brighter and sharper, and the prices have come down. Most of the newer projectors use internal LCD panels, prisms, and mirrors, so just one projection lens is needed and setup is very simple. Some even include an audio amplifier and loudspeakers.

Some of the more popular manufacturers are Sharp, Eiki, Boxlite, and Sony, to name just a few. Prices for the smaller portables start around $3,000.00. At the other end of the scale, you'll find machines over $50,000, like the Hughes/JVC Light Valve projector, which can easily fill a 30' x 40' screen (yes, that's feet, not inches)!

I formerly worked at a Scanticon conference center, where we used one of these for football "tailgate" parties in our ballroom, seating around 800 people ... now that's a party!

You can find a few projectors at mail order retail dealers, such as **Midwest Micro (1-800-682-2511)**, or **J & R Computer World (1-800-221-8180)**.

Your local A-V dealer probably has a wide selection, and is likely to have some rental projectors available, if you need one only occasionally.

Greg Miller
State College, PA
gemiller@commedge.com

ANSWERS TO #10995 - OCT. 1999

I am looking for a source of 434 MHz miniature TV transmitters.

#1 Miniature TV transmitters can be obtained from Ramsey Electronics, Inc., of Victor, NY. Order toll-free 1-800-446-2295. They have transmitters with video only, and video and audio.

Check out their ad in *Nuts & Volts*, Oct. '99 page 40.

Joseph Kish
Clackamas, OR

#2 If you are a licensed amateur (ham radio operator), PC Electronics, www.hamtv.com or 2522 Paxson Lane, Arcadia, CA 91007, tel: 818-447-4565 has several well-designed video transmitter boards suitable for all sorts of projects.

If you are not a licensed amateur, any use of 434 (or 420-450 megacycle) is illegal, as those are frequencies in the 70cm amateur band requiring a license.

One way transmissions, commercial transmissions, or use by any other than amateur two-way communications are illegal. Further, thousands of hams spend tens of thousands of hours searching for weak signals there as part of their amateur activities. And many areas have amateur video repeaters with inputs on that frequency.

Do you want your operations monitored by potentially thousands of hams over hundreds of square miles if you inadvertently key up one of their repeaters? This has happened, many times.

Many spy shops peddle (illegal) 434 megacycle and similar video transmitters. Be aware the performance of these things always is extremely exaggerated.

What a dedicated, talented, equipped, and experienced ham with huge towers and antennas can achieve with hundreds of hours of piddling, does not equate to what a little board will do when hidden in a surveillance scenario by someone not experienced in the technology.

Wireless video is a long way from plug and play, regardless of what the ads may have you believe.

The amateur frequencies are popular for commercial wireless video surveillance because the equipment is cheaper and higher powered than legitimate FCC type accepted equipment. 434 in particular, is common because that is a popular remote control frequency in Germany, and inexpensive SAW (Surface Acoustic Wave) resonators on 434 are easy to find and easy to design around.

If you are an amateur, PC Electronics is an honest and competent manufacturer and would be pleased to assist you. If you are not an amateur, look towards legal FCC type accepted wireless video equipment on 900 or 2.4 gigs.

Steve Uhrig
Street, MD

by Evert Fruitman W7RXV

Robbi's Violin/Guitar Tuner

"Hint, hint Dad, only 10 more shopping days until my birthday, hint, hint, hint." "That new video will be out in a week, hint, hint, hint." I asked Robbi to quit dropping hints and just tell me what she wanted for her birthday. We laughed most of the way home from school that day. And yes, she still has the video. In fact, if we will get the chips and dips, we can watch it, too.

While still in high school, our youngest gave subtle hints like that. So, it came as no surprise when a few years later, she asked me to make her a tuner. Of course, the music stores had tuners, but then they had metronomes too and she could still hear her sister Joy's Loud Enough Metronome echoing around here. It got written up under that title elsewhere. Some of the commercial tuners have LEDs, LCD displays, analog meters, or some combination of those indicators. They are almost automatic tuners. They start at $20.00 and go up. A musician told me that with Robbi's tuner, instead of watching a dial or a light, you get to use your ear. He said that that helps keep your ear trained.

At the ripe old age of 10, Robbi decided to take up violin. Fifteen years later, she still fiddles around with it. Since our piano usually needed tuning and she wanted something a bit more portable, she asked for the tuner. That couldn't be any harder to make than the metronome, or an 80 meter transmitter, or a light meter, or a ... could it?

Photo A. Robbi's Tuner
Four-note tuner features simple, single-switch control. Turning the knob past either endnote turns off the tuner.

Photo B. Robbi's Tuner II
Nine-note Violin/Guitar Tuner
This tuner covers the ranges of both the guitar and the violin. Since it has a 12-position switch, you could expand it even more.

The Tuner

She had a good point, and I need only a gentle hint to start working in the playroom. Photo A and Figure 1 show the results of that logic. At first, all that was needed was a simple violin tuner. It had to give the four notes G, D, A, and E. Simple enough, one pole of a two pole, six-position switch supplies power to one of the tone-select resistors. The other pole supplies power to the regulator. Move the switch to an empty position and you have turned off the tuner.

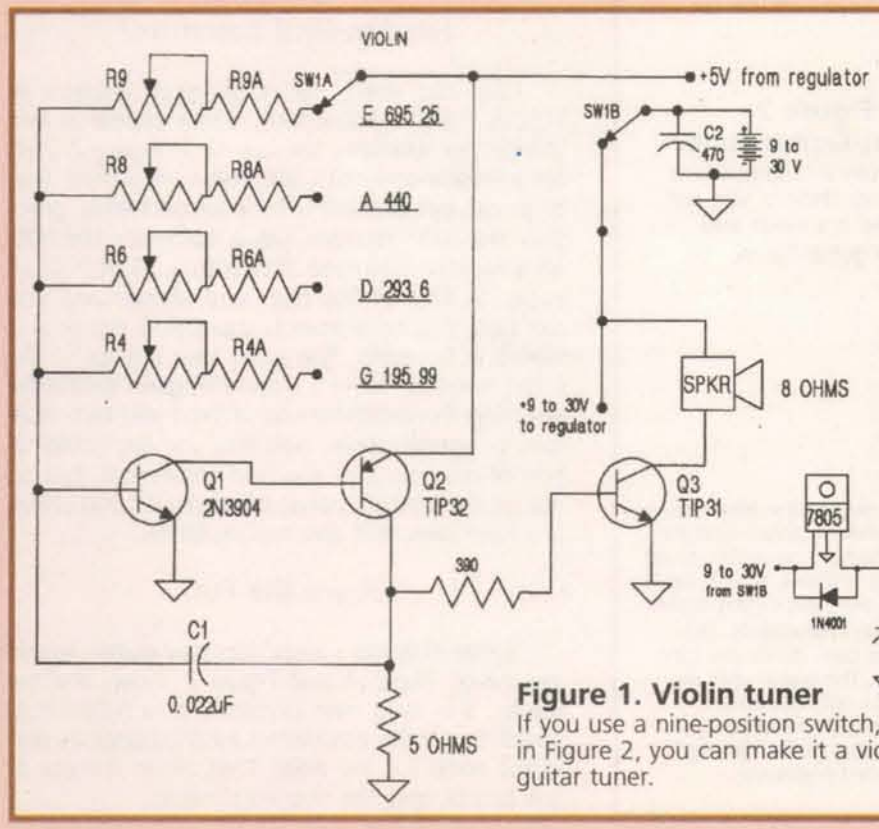


Figure 1. Violin tuner
If you use a nine-position switch, as shown in Figure 2, you can make it a violin and a guitar tuner.

Somewhat simpler than the tuner in Figure 2, this tuner gave ideas of what would probably work better. If you want to duplicate this one, change the 390-ohm resistor to 39 ohms and use a 2N3904 for Q2. Also change C1 to 0.068uF. That way you can use the resistor values from Table 1 (Figure 3). Since this one originally went for the higher notes, C1 was small, 0.022. That would change the values of R4, R6, R8, and R9. Make sure that C2 has a higher voltage rating than the battery. Higher voltage will give a louder tone.

How and Why

Q1, Q2, and the 0.022 uF capacitor in Figure 1 with the five-ohm resistor and one of the tone-select resistors make a complimentary-pair oscillator. The 390-ohm resistor couples the direct-current squarewave from Q2 to Q3 which drives the speaker.

When the oscillator first gets power, C1 starts charging through one of the tone-select resistors. When it reaches about 0.55 volts, Q1 turns on. That turns on Q2 through its emitter-base junction and the collector-emitter path of Q1. When Q2 turns on, that connects the top of the five-ohm resistor to the five volts from the regulator. That action discharges C1. That turns off Q1, which

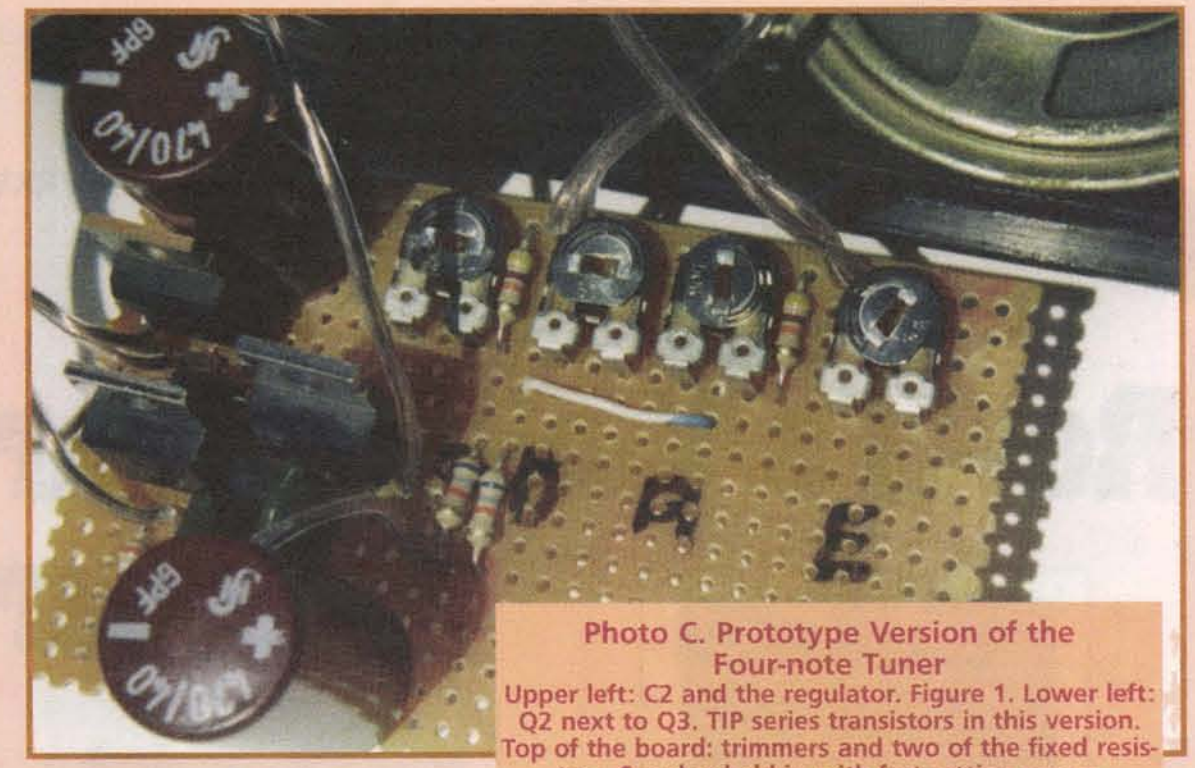


Photo C. Prototype Version of the Four-note Tuner
Upper left: C2 and the regulator. Figure 1. Lower left: Q2 next to Q3. TIP series transistors in this version. Top of the board: trimmers and two of the fixed resistors. Speaker held in with fast-setting epoxy.

turns off Q2. Then C1 starts charging again, which starts another cycle.

All of this action takes place in a period of time determined mostly by the size of C1 and the tone-select resistor. In essence, the collector of Q2 and the top of the five-ohm resistor switch from zero volts to plus five volts many times per second. Couple that signal to a speaker amplifier and you have an almost instant tuner. The speaker amplifier, Q3, draws power only when its base, through the 390-ohm resistor, goes above about 0.6 volts. This drives current pulses through Q3. The current pulses in the collector of Q3 drive the speaker.

High Current

Even though it is for but a short time, both the five-ohm resistor and the speaker do draw a fair bit of current. Five volts divided by five ohms equals about one amp. The current builds up and decays as opposed to a sudden, full on and full off state. So, one amp is close enough for our arithmetic. The same idea applies to the speaker, nine volts, eight ohms. Other things happen there because of the small but measurable amount of inductance in the speaker and the relatively sudden changes in current. That happens because the basic oscillator, Q1, and Q2 turn on and turn off at the same time. This delivers a squarewave to the speaker amplifier.

All of this means that you want a capacitor to store the current needed for the short but high current pulses to the two sections of the tuner. Capacitor C3 supplies the current to the oscillator section while C2 does the same for the speaker section. You may get away without C2 while the battery is still fresh. DO NOT even think about leaving out C3. Because of the short, high current demands of Q2, leaving off C3 can cause some strange, even unpleasant results. If you plan on the louder sound given by three nine-volt batteries, use a 35-volt capacitor for C2 as shown in the parts list.

Regulator Protection

Because, under some conditions, C3 could discharge through the regulator, put in the diode across the regulator. A cheap, one amp diode such as the 1N4001 gives the regulator good protection. Keep this in mind anytime that you have a relatively large capacitor across the output of a three-terminal regulator. The prototype model has the diode in it, from habit. However, by oversight on my part, it got left off of the final version. After extensive tests, the regulator survived. It looks like, in this case, the tuner bleeds off the cap without letting it hurt the regulator.

You need the regulator since voltage changes cause some change in pitch. While I do not regard this as a precision instrument, a regulator helps stabilize the tones. That gives the instrument the ability to ignore the normal changes in battery voltage over the useful life of the battery. That makes this a practical instrument.

TABLE 1. TUNING NOTES AND TONES — Figure 3

Note	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E
Violin Mandolin																	195.99				293.6				440				659.25
Guitar								82.4			110			146.8			195.99		246.94			329.6							
Bass Guitar	42.20			55			73.41			97.99																			

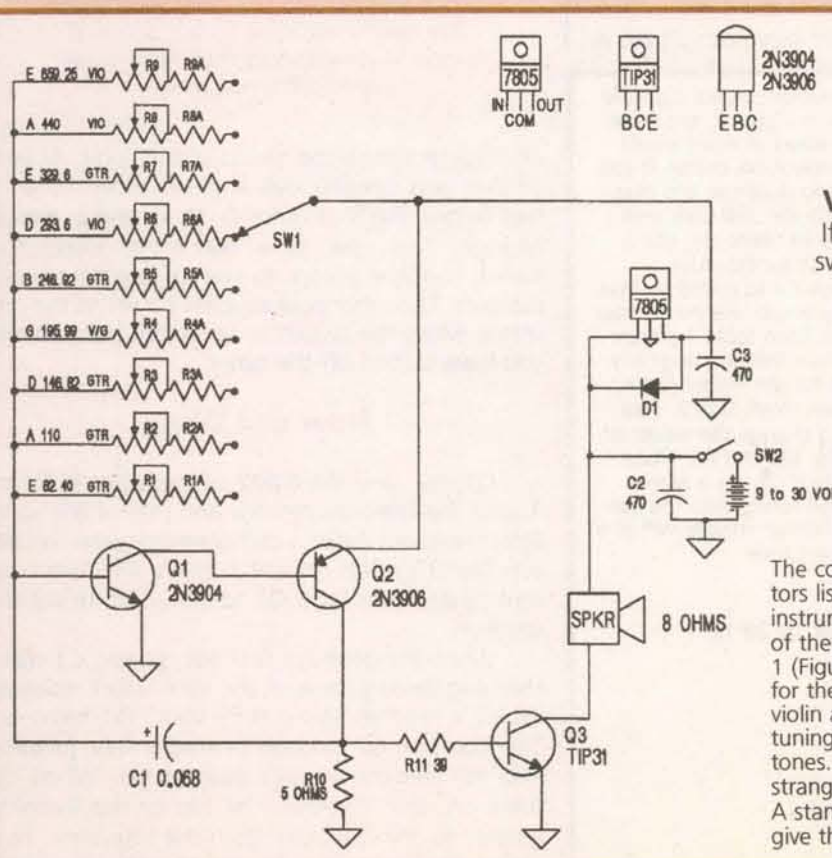


Figure 2. Violin/Guitar tuner
If you use a nine-position switch, as shown, you can make it a violin and a guitar tuner.

The column next to the trim resistors lists the tuning tones with the instrument. Table 3 gives the values of the tuning resistors, R1-R9. Table 1 (Figure 3) gives the tuning notes for the various instruments. The violin and the bass guitar use four tuning tones. The guitar uses six tones. You do not have to use strange, hard-to-find resistors. A standard value and a trimmer give the needed resistance.

Hard-to-Find Resistors?

You can make the tone-select resistors in Figures 1 and 2 easier than it may appear at first glance. For example, the low G, in Figure 2, calls for a resistance of 115,500 ohms: measured. Few of us can get or want to look for odd-value, precision resistors. You can get a common 100,000-ohm resistor. Combine that with a 25,000 or an easier to find 47,000-ohm trim resistor and you can tune that tone from G sharp to G flat or anywhere in between. The same idea applies to the other resistors. Table 3 (Figure 6) gives details for selecting the combinations of fixed and trim resistors for specific tones. You may use any combination of resistors that you find convenient, but do not let the total resistance fall under 27,000 ohms, as I have seen that give real problems.

Share the Fun

Some of Robbi's associates play guitar. Need I say more? Photo B and Figure 2 shows the net results. We used nine positions of a 12-position switch to get the extra notes for the guitar, as well as the notes for the violin. That allows the use of one box to tune the two instruments.

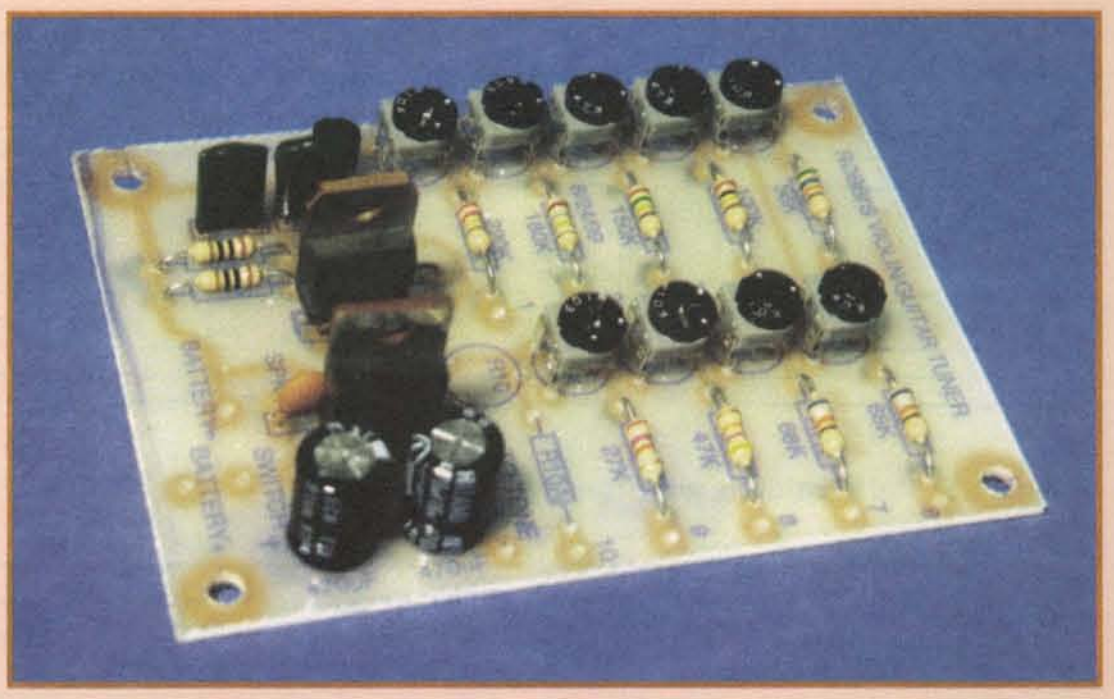


Photo D. Printed Circuit Board with Silkscreening

Following the writing on the board lets you put most of the tuner together without having to look at a diagram. Q1 is at the top just to the left of the first trim resistor. C1, which consists of two capacitors in parallel, sits in front of Q1, the 2N3904. R10, the two 10-ohm resistors, sit in front of C1. Q2 is hidden in back of Q3. Q3, the TIP31, is in back of the 7805 regulator. C2 and C3 sit in front of the regulator. The ceramic capacitor in back of and to the left of the regulator is more habit than necessity. It does not show up in the diagram. With C2 and C3 so close to the regulator, you could leave out the 0.1uF ceramic caps. In fact, you could put D1, the protection diode, there instead. It got left off of the layout. However, despite the potential danger to the regulator mentioned in the text, the tuner seems to bleed off the charge without letting it bother the regulator. The photo was made before cluttering up the board with the wires to the speaker, the switches, and the battery.

Table 1 (Figure 3) lists tuner notes and tones for violin, mandolin, guitar, and bass guitar. For reference, Table 2 (Figure 4) lists notes and their tones from low E on the bass guitar, to high G above E on the violin. Figure 5 puts the nine notes for the tuner on the staff. Additionally, it gives the four notes of the bass guitar. It shows the tones for all of those notes.

Stability

I would not classify Robbi's Tuner as a precision instrument. It stays within about 1% of where I set it. The complimentary oscillator, Q1-Q2, gives good temperature compensation. The inexpensive, green, polyester capacitors show a low temperature coefficient. From a practical standpoint, a hot soldering iron applied to one lead of the capacitor C1 caused about a one or two Hz change at 440. That figures out as less than one-half of one percent.

Following removal of the heat, the tone quickly returned to normal as indicated by a counter. I did not wait for the mounting wire to melt out of the capacitor. While this is not an environmental-chamber test, it gives an idea of what to expect. I have been known to put some of my 'toys' in the refrigerator for several hours and then take measurements. If this tuner is going on tour in your guitar case, I doubt that it will see extreme temperatures.

The voltage regulator stabilizes the voltage applied to the tuning components. You can get some idea of how much that stabilized the tone when you turn off the tuner. As the voltage from capacitors C2 and C3 falls to the point where the regulator drops out of regulation, the pitch changes enough to get your attention. If you use a couple of nine-volt batteries, the tuner will give loud tuning tones for a long time.

Sound Level

A sound-level meter shows 61-62 dBSPL (Sound Pressure Level) with a nine-volt power supply and about 72dB with 18 volts. At 18v, it draws 24mA. At nine volts it draws about 20mA. I could not get a reading above 21 volts as my tuner has only 16-volt capacitors in it. The

TABLE 2. PARTICULAR NOTES OF INTEREST AND THEIR TONES **Figure 4**

A	A#	B	C	C#	D	D#	E	F	F#	G	G#
							41.20	43.65	46.24	48.99	51.91
55	58.27	61.73	65.40	69.29	73.41	77.78	82.40	87.30	92.49	97.99	103.82
110	116.54	123.47	130.81	138.59	146.83	155.56	164.81	174.61	184.99	195.99	207.65
220	233.08	246.94	261.62	277.18	293.66	311.12	329.62	349.22	369.99	391.99	415.30
440	466.16	493.88	523.25	554.36	587.32	622.54	659.25	698.45	739.98	783.99	830.60

For reference, notes and their tones from low E on the bass guitar, to high G above the violin. To get the next higher note in the chromatic scale, multiply a note by 1.0594631. To get the next lower note, divide by the same. For example: D# below low E, divide 41.20 by 1.0594631 to get 38.89, D sharp or E flat.

NOTE	FREQUENCY		TRIMMER		FIXED
E	82.4	R1	100K	R1A	220K
A	110	R2	47K	R2A	180K
D	146.8	R3	47K	R3A	150K
G	195.99	R4	47K	R4A	100K
B	246.94	R5	100K	R5A	56K
D	293.6	R6	10K	R6A	68K
E	329.6	R7	10K	R7A	68K
A	440	R8	10K	R8A	47K
E	659.25	R9	10K	R9A	27K

TABLE 3. NOTES, FREQUENCIES, AND RESISTORS

Figure 6

This table may help you select the resistors you want for the desired tuning range for Photo B (Figure 2). G, D, A, and the last E are used for the violin. See Table 1 for more information.

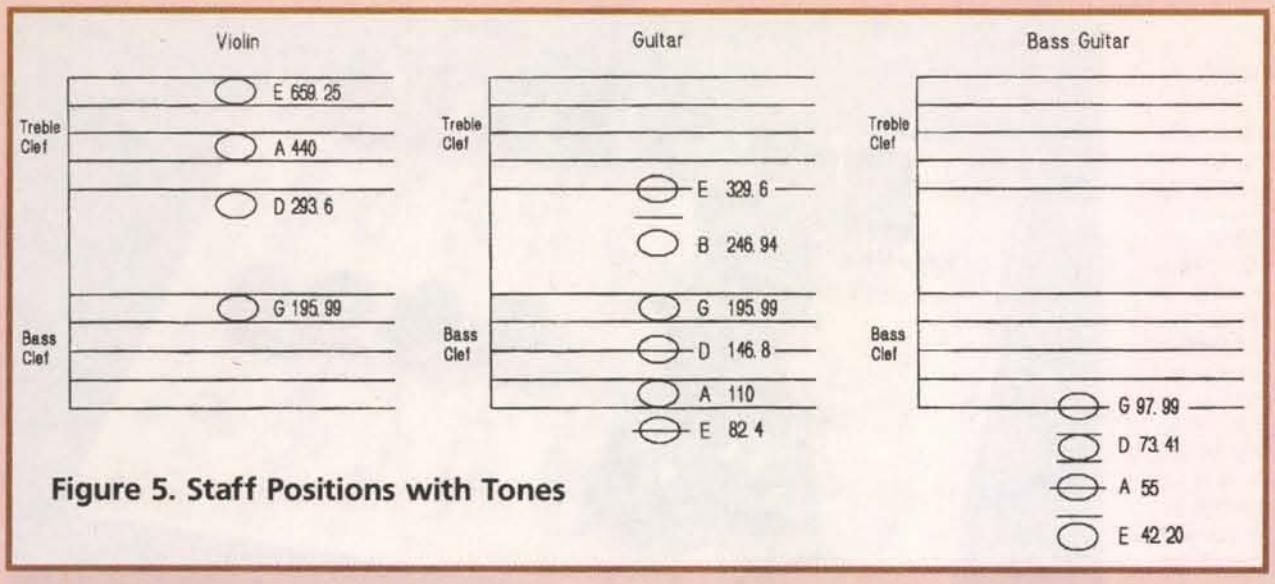


Figure 5. Staff Positions with Tones

Figure 9. 1:1, shows the foil side of the tuner board.

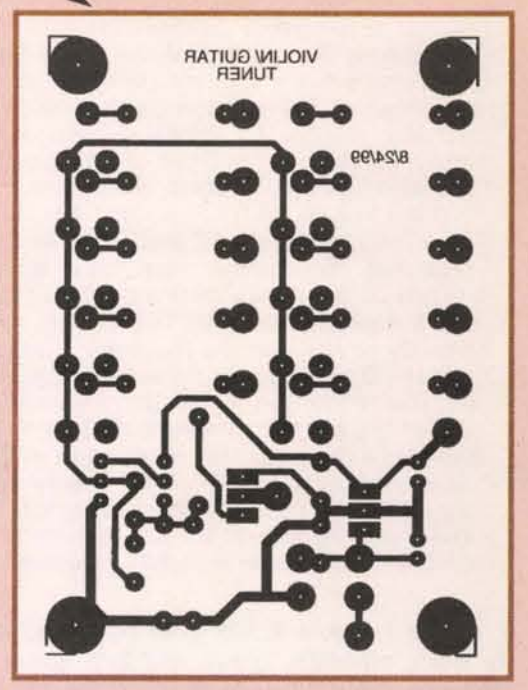


Figure 7. 1:1 of the top of the board; which way and where the parts go.

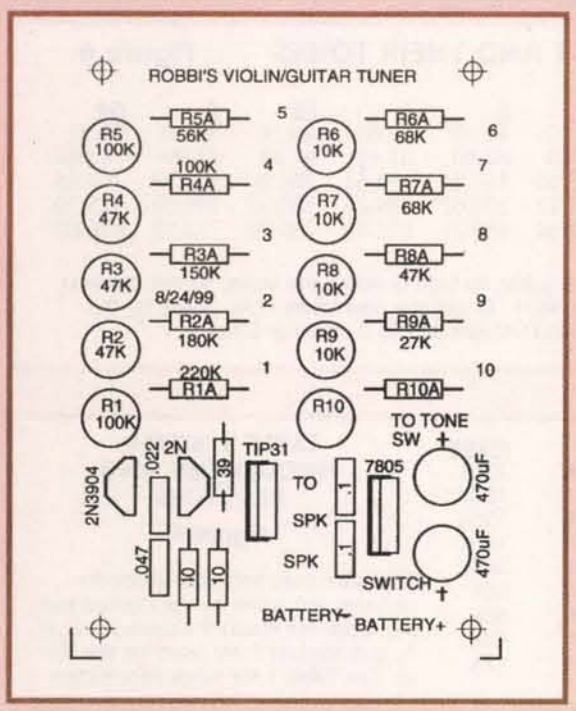
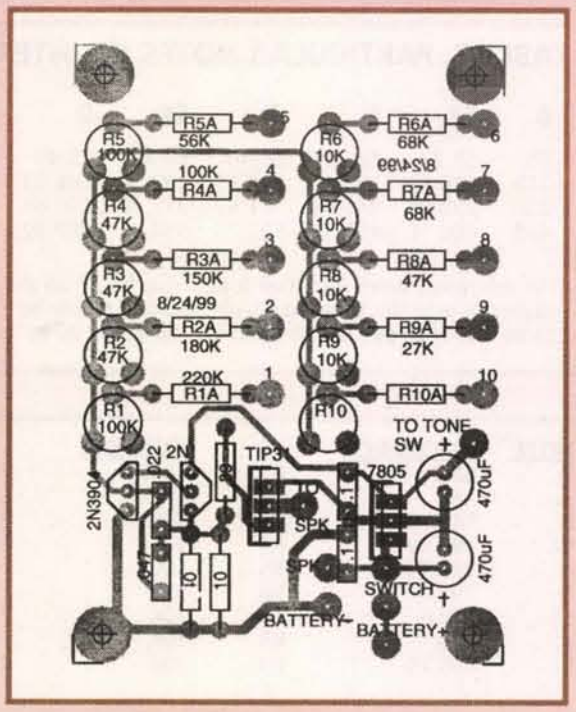


Figure 8. X-ray view from the top showing parts placement, as well as the foil on the under side of the board.



sound level went up, but the higher voltage stressed capacitor C2 enough to show on the current meter in the power supply. The rest of the system will work with as much as 27 volts.

Battery Life

With a nominal 580mA-hour capacity, look for about 20-25 hours battery life from a nine-volt alkaline battery. If you want to use a bigger box and larger batteries, you can extend the run time. A set of six AA batteries should give about 45 hours of use. That is a lot of tuning.

Other Uses

As you change the tone-select switch, you will hear familiar intervals. If you connected a push-button switch between the regulator and SW1, you could play simple tunes by pressing the button and manipulating SW1. Since that is a bit crude, you could replace SW1 with as many momentary-contact buttons as you want and make an "instant toy organ." Just connect one side of each of the buttons to the regulator and the other side to one of the tone-select resistors. Follow Table 2 for the tones.

If that thought appeals to you, I will leave it to your imagination and ingenuity to make the tuner into a 'keyboard.'

If you use a larger capacitor, about 10uF, and larger tone-select resistors, you could make a metronome. This circuit lends itself to many uses.

Construction

If your interest extends no further than the simple, four-note tuner, you could start with Figure 1 and Photo C. That suggests one layout. It put C2 next to the regulator on the rear of the board. C3, the timing capacitors, with Q1 and Q2 went on the front of the board.

A Simpler Solution

Photo D shows what may be a simpler way to make the tuner. One of the high quality printed boards from Far Circuits can make the construction easier for you. If all you need is the four note tuner, just follow the silkscreening on the top of the board and install the resistors for the four violin tones. Use Table 1 and Table 3 to help you pick resistors. The same idea applies if all you want is the six-note guitar tuner. Just put the resistors on the board as indicated by the tables. Then put the six wires on the switch next to each other. Add the rest of the resistors, the transistors, and the capacitors.

Board Layouts

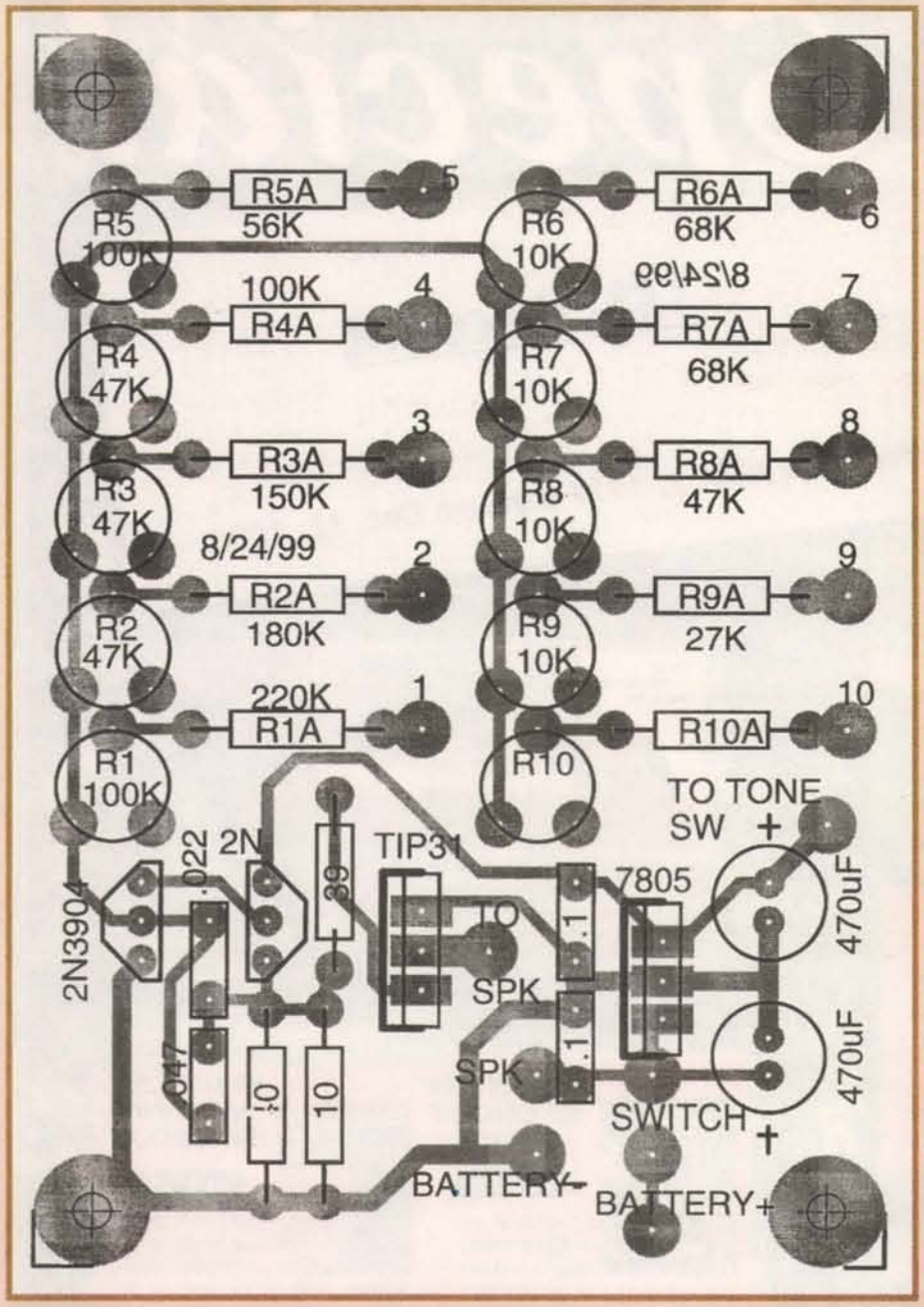
Fred, of Far Circuits, kindly allowed me to include the layouts for those who like to do their own boards from etch, or is that, from scratch? Figure 7 shows a 1:1 of the top of the board: which way and where the parts go. Figure 8 is an x-ray view from the top. Figure 9, also 1:1, shows the foil side of the tuner board. Figure 10 gives you a 2:1 x-ray view of the board.

Once you have decided on your board, lay out the box and make the mounting holes for the speaker and the controls. Mount the speaker last. Some speakers have mounting clips with them. Mine did not. I used a fast setting epoxy. Run the wires from the board to the switches, to the speaker, and to the battery.

Tune-up Time

Double check to see that the plus (+) sign on the electrolytic capacitors, C2 and C3, goes next to the plus sign on the board. Be sure that the NPN

Figure 10. A 2:1 x-ray view of the board.



(2N3904) and the PNP (2N3906) transistors went into the correct places. Make sure that the battery plus goes to the assigned place. When all looks right, turn on the power switch. Run the tone-select switch through its range. You should hear the various tones. Most likely they will not be on pitch, but we will take care of that now.

Counter Measures

If you have, or can get a counter for a little while, connect it to R10 in Figure 2. BE SURE to follow the manufacturer's thoughts on input signal level for the counter. The indicated point will deliver a solid five-volt peak signal. Connecting the counter from the collector of Q3 to battery minus may work. However, the signal from that point may confuse the counter. The signal at that point rings due to the inductance in the speaker and the sudden change in current from the squarewave pulses.

Additionally, if you went for a louder sound and used a higher voltage battery, you will have to consider the larger signal that would send to the counter. Some counters will read the signal directly across the speaker. But the signal across the speaker does have a strange waveform.

Once you find a suitable signal source – and some counters are not as fussy as mine – select a tone. Compare the reading on the counter with the specified frequency shown on the drawing or in one of the tables. Adjust the trim resistor as needed. You will not need to readjust the trimmers as they do not interact with each other. Simply 'tweek' the trimmers as needed and then double check them. A dot of finger-nail polish or cement should secure the adjustment.

Hear! Hear!

If you wish to tune it by ear, find a good, stable tone source and adjust the trimmers as needed. If you have an accurately calibrated signal generator, that could help. Connect it to a suitable amplifier and a loudspeaker.

Perhaps you could run the signal generator through one of the auxiliary inputs on a hi-fi system. That would give you a steady tone for tuning. If needed, 'Zero' the signal generator against a well-tuned piano or other instrument. Once you have your comparison signal-source, adjust the trimmers as needed.

If All Else Fails

Lacking any of the above, counter, signal generator, a friend with a good ear, sit down at the piano and tune the trimmers. The tuner gives a non-sinewave tone. It contains many harmonics. You will have to listen carefully, but you will certainly be able to tell when the tuner and the tuning note agree. Once you have it tuned, put the cover on and you can start tuning your violin, guitar, or both.

I hope that Robbi's Violin/Guitar Tuner helps you to stay in tune. **NV**

PARTS LIST / FIGURE 2 / PHOTO B

TRIMMER			FIXED		NOTE/INSTRUMENT
R1	100K	271-284	R1A	220K	(E GTR)
R2	47K	271-283	R2A	180K	(A GTR)
R3	47K	271-283	R3A	150K	(D GTR)
R4	47K	271-283	R4A	100K	(G GTR/VIO)
R5	100K	271-284	R5A	56K	(B GTR)
R6	10K	271-282	R6A	68K	(D VIO)
R7	10K	271-282	R7A	68K	(E GTR)
R8	10K	271-282	R8A	47K	(A VIO)
R9	10K	271-282	R9A	27K	(E VIO)

R10 5 ohms two each 10 ohm resistors in parallel or a single 4.7 ohm resistor is okay. Generally, it is easier to find the 10s. The board from **Far Circuits** will accommodate the two resistors.
R11 39 33-47 okay
C1 0.068uF one ea. 0.022 and 0.047 in parallel. 272-1066 and 272-1068 (That adds up to 0.069, 0.068 is a standard value, which you may be able to find.)
C2 470/16 272-957 If you use two nine-volt batteries, use the 272-1030, rated at 35V.
C3 470/16 272-957 This cap never sees more than five volts
Q1 2N3904 NPN 276-1603 (15 to a package, watch the pin connections)
Q2 2N3906 PNP 276-1604 (15 to a package, watch the pin connections)
Q3 TIP31 276-2017
D1 1N4001 or other one-amp power diode, optional in this case.
7805 276-1770 Five-volt Regulator
SW1 ON/OFF SPST 275-406
SW2 TONE-SELECT 1 pole 12 position 275-1385

Speaker two-inch replacement type 40-250 or a 273-092 eight-ohm (4-16 ohms okay).
The speaker may be as large as you like: one inch to an on-sale 5x7 oval. It will just take a bigger box.

Box About 5x2x2 1/4 see what they have in stock when you get there.

Circuit board Perf board, or an easy-to-wire printed circuit board from **Far Circuits, 18 N. 640 Field Court, Dundee, IL 60118**

They always give the project a nice look and they shorten construction time.

Layouts: Figures 7-10.

If you have a neighborhood wholesale electronics store, feel free to take the parts list there. Except for the printed circuit board, they will have equivalent parts that will work just as well as the ones listed above.

A word to the wise

Fact of the matter is, it may be necessary to get transistors from some place other than the ones listed above. Unless you have a way to verify that they are 2N3904s or equal, that is probably the safest thing to do. Of the last four packages of 276-1617 transistors, a good percentage of the transistors had the emitter and the collector leads switched. Their package ALWAYS shows the collector on one end, NEVER in the middle. I found out that a number of them had the collector in the middle. I have enough electronics background to figure it out and correct it. Many readers may lack the 40+ years practice that I have had which helps with that kind of problem.

The second problem that came to light, or should I say lack of light resulted from them putting DARLINGTON-PAIR transistors in that package. I put together one of the bike lights (*Nuts & Volts* Oct. '99) and spent a frustrating 30 minutes trying to figure out why one of the LEDs lit, and I needed a flashlight to see the other one. It blinked, but oh, such a feeble light.

Again, careful testing with an analog ohmmeter on the RX1 scale showed that the transistors for that LED, had too much voltage drop from the emitter-base to pass as a simple NPN transistor. I took back 10 or so and gave them to the clerk. He will talk to their purchasing/QC next week. I took my ohmmeter in and tested the next 30 transistors before buying them. Several of them had the collector base leads reversed.

In the last 20-25 years, I have found an occasional questionable transistor once in 200 or so transistors in those packages. I have no problem with that. But switching the leads or putting a Darlington-pair in the package could cause a lot of frustration to those who want to build these, or other projects with the left-overs.

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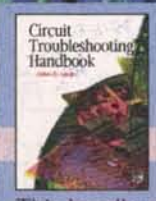

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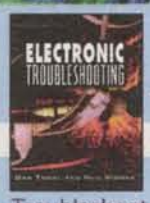

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Suggested list price is $15.95.

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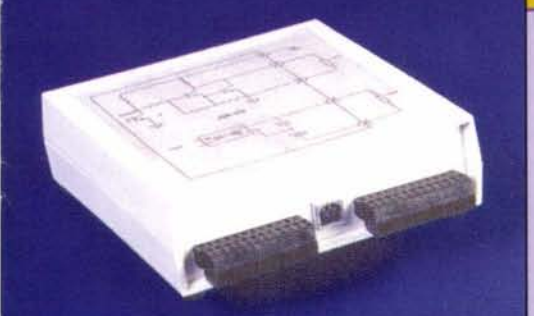

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The module replaces internal PC-based plug-in cards in various test, control, and measurement applications.

Complete data is available on J-Works web site at www.j-works.com

Single unit price for the Model JSB-320 range $205.00 to $299.00. Delivery is from stock.

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NHRC-4/M2 REPEATER CONTROLLER

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The NHRC-4/M2 repeater controller provides CW ID, ID timer, individual timeout timers for the main and remote base ports, and a hang timer. Five different distinctive courtesy tones indicate channel activity and remote base status. A digital output is included for control applications. Or the digital output can be configured to control a fan to run while the transmitter is on and for a programmable amount of time afterward.

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Delay Sweep	YES	ALT-MAG	ALT-MAG	ALT-MAG
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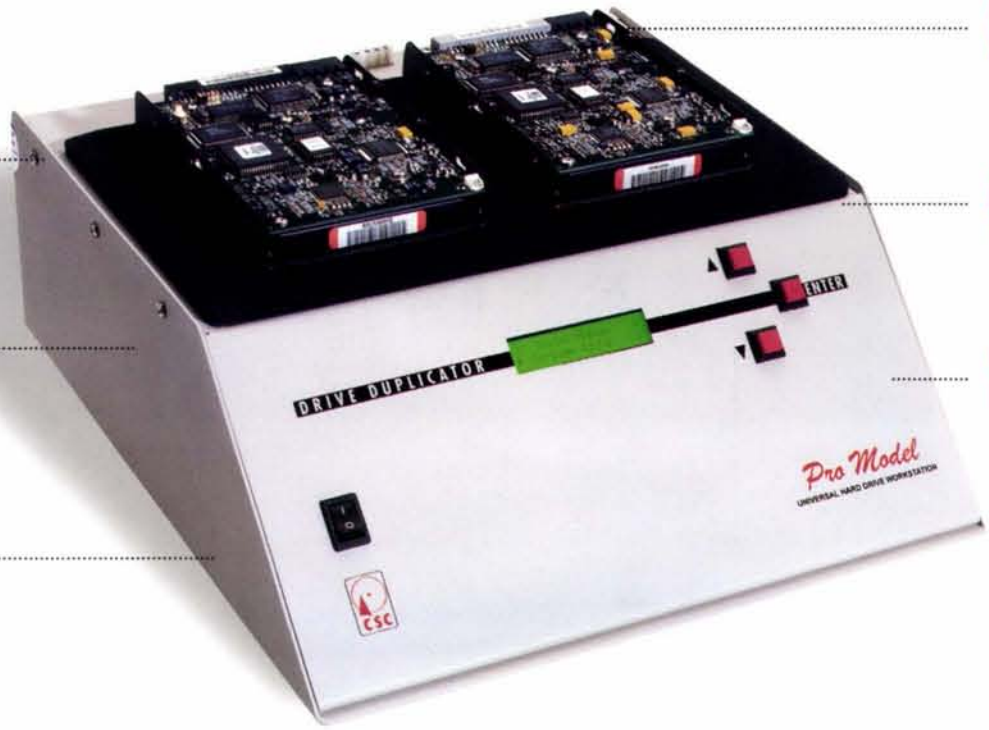

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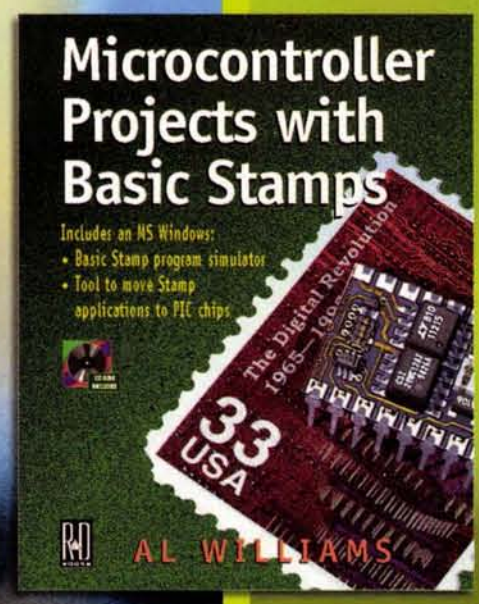

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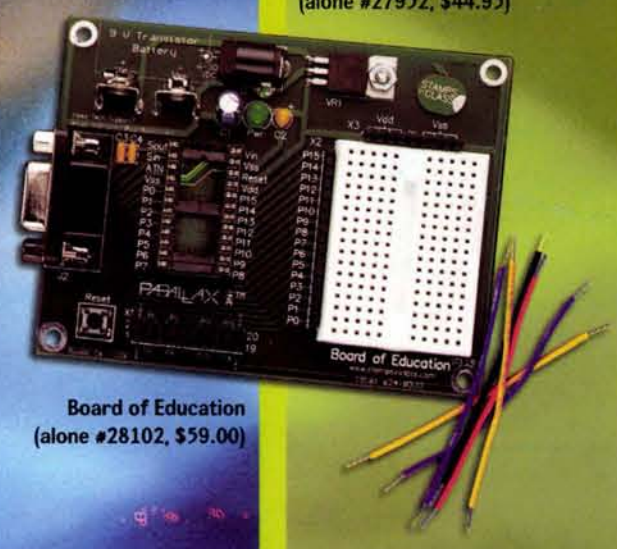

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